Chapter 3

Affected Environment

3.0 Introduction

This chapter describes the physical and biological environment, public uses, cultural resources, and socioeconomic conditions, as they exist in the Monument today. These existing conditions represent the environment that would be affected by the alternatives being considered in this CCP/EIS. The affected environment is the baseline for the comparison of impacts of alternatives in the environmental analysis in Chapter 4.

3.0.1 Methods and Sources of Information

A great deal of information currently exists regarding the resources in the Monument. Extensive research and environmental monitoring has been and is currently being conducted on Monument lands. In many cases, however, comprehensive inventories of Monument lands have not been completed to a level sufficient for intensive management of natural and cultural resources. In-depth resource inventories for cultural resources, wildlife, vegetation, and public use activities are either currently underway or pending the selection of a preferred management alternative.

The best available information was used to describe the existing conditions in the Monument. The information used in this analysis was obtained from a variety of sources.

- Other DOE reports and NEPA documentation, especially the CLUP.
- Relevant scientific literature (see Appendix R for reference sources).
- Existing databases and inventories.
- Consultations with other resource professionals.
- Personal knowledge of resources based on field visits and experience.

Where relevant, the reader is referred to the appendices and/or the original source material for detailed information regarding the affected environment in the Monument.

3.0.2 Study Area

The area being considered in this CCP/EIS is located near the Tri-Cities (Kennewick, Pasco, and Richland) in south-central Washington State.

The Monument lies along both sides of the Columbia River, approximately 30 miles north of the Oregon border, 200 miles east of the Pacific Ocean, 110 miles west of Idaho border, and 150 miles south of the Canadian border (see Map 1). Most of the Monument's 195,777 acres are located in Benton, Franklin and Grant Counties, although the northeast corner extends a short distance into Adams County.

The Monument is about 30 miles north to south and 24 miles east to west. The Columbia River flows through the Monument and, turning south, forms part of the eastern boundary. The Rattlesnake Hills, of which Rattlesnake Mountain is a part, are the southwestern boundary of the Monument, Umtanum Ridge the western boundary, and the Saddle Mountains the northern boundary. The lands that border the Monument to the west, north and east are principally range and agricultural land.

The Monument lies between three major population centers: Portland, Oregon (230 miles by road); Seattle, Washington (225 miles); and Spokane, Washington (140 miles). The cities of Kennewick, Pasco, Richland (the Tri-Cities), and West Richland constitute the nearest population centers and are located just south of the Monument.

3.1 Geographic/Ecosystem Setting

The state of Washington is generally thought of as temperate or even wet; in reality, however, most of the state east of the Cascade Mountain Range is quite dry, to the point of meeting the definition of desert.

The Monument comprises lands originally acquired by the federal government in 1943 for the Manhattan Project. All the land within the Monument currently belongs to the DOE as part of the 375,000-acre Hanford Site. The Monument was created primarily from parts of the Hanford Site that were considered safety and security buffers during the weapons production period of the site's history. As such, the Monument forms a large horseshoe-shaped area around what is generally known as Central Hanford and, because use has been restricted in the area, the Monument provides a buffer for the smaller areas currently used for storage of nuclear materials, waste storage, waste disposal, and the Energy Northwest Power Plant.

When European settlers first arrived in the Pacific Northwest, they found a harsh, but surprisingly productive arid landscape that today is identified as the Columbia Basin Ecoregion (DOE-Richland Office 1996). This area historically included over 14.8 million acres of steppe and shrub-steppe vegetation across most of central and southeastern Washington State (Franklin and Dyrness 1973), as well as portions of north-central Oregon.

Today, much of the Columbia Basin Ecoregion has been converted into farms and urban centers. However, the protected status of the Hanford Site since 1943 resulted in its becoming a refuge for native plants, animals and biological communities that were once far more common in the surrounding landscape. Equally important, the portion of the Columbia River within the Hanford Site is unique within the post-dam Columbia River system in the United States. Within the Hanford Site, the river is essentially free flowing through an approximately 51-mile (46.5 miles within the Monument) segment. This segment is called the Hanford Reach. The Hanford Reach extends from the upper end of the McNary Dam Reservoir to Priest Rapids Dam and contains significant riparian habitat that is otherwise rare within the Columbia River system (FWS 1980, National Park Service 1994). It is because of this duel juxtaposition of increasingly rare habitats—the only free-flowing, non-tidal stretch of the Columbia River remaining in the United States and the largest remnant of the shrub-steppe ecosystem that dominated the Columbia Basin prior to European settlement—that President Clinton established the Hanford Reach National Monument through Presidential Proclamation in June 2000.

The Monument is characterized as a shrub-steppe ecosystem. Such ecosystems are typically dominated by a shrub overstory with a grass understory. In the early 1800s, the dominant plants in the area were big sagebrush underlain by perennial Sandberg's bluegrass and bluebunch wheatgrass. With the advent of settlement, livestock grazing and agricultural production contributed to colonization by non-native plant species that currently dominate large portions of the landscape. Although agriculture and livestock production were the primary subsistence activities in the area at the turn of the century, these activities ceased when the Hanford Site was designated in 1943. Remnants of past agricultural practices are still evident.

At 195,777 acres, the Monument, along with the Department of Defense's (DOD) Yakima Training Center, retain the largest remaining blocks of relatively undisturbed shrub-steppe in the Columbia Basin Ecoregion (Smith 1994, Soll 1999; see Map 2). When settlers arrived, the vegetation in the ecoregion consisted primarily of shrubs, perennial bunchgrasses, and a variety of forbs. An estimated 60% of shrub-steppe in Washington has been converted to agriculture or other uses. Much of what remains is in small parcels in shallow rocky soils or has been degraded by historic land uses (mostly livestock grazing). This conversion of land extends even into the Monument; the Monument encompasses undeveloped land interspersed with industrial development along the southern shoreline of the Columbia River, and human-made intrusions, such as roads, power lines, irrigation canals, communications structures, and remnant domestic plants, are evident throughout the Monument.

The Monument contains some of the best remaining large-scale examples of the shrub-steppe vegetation type in the Pacific Northwest, supporting habitat for many species of native wildlife (including shrub-steppe obligate species), a diverse array of native plant communities (including many threatened and endangered taxa) and microbiotic crusts, and a unique invertebrate fauna that is still being catalogued (Soll et al. 1999, Evans et al. 2003). Many places in the Monument are relatively free of non-native species and are extensive enough to retain characteristic populations of shrub-steppe plants and animals that are absent or scarce in other areas.

The Monument's importance as a refuge for the shrub-steppe ecosystem is not solely related to size, however. The presence of a large diversity of physical features and examples of rare, undeveloped deep and sandy soil has led to a corresponding diversity of plant and animal communities. Because it is located within the hottest and driest part of the ecoregion, the Monument also retains some of its own uniqueness and fragility.

The Monument's other key feature—the Hanford Reach—is home to the most important salmonid spawning grounds remaining on the Columbia River. The Hanford Reach and associated riparian zones provide habitat for numerous wildlife and plant species, including remnant habitat for aquatic organisms that were widespread before the remainder of the Columbia River system was converted to reservoirs. Surveys have identified several rare plant associations along the shoreline and islands of the reach (Salstrom and Easterly 1995, Soll and Soper 1996), further defining the Monument's importance to the nation.

It was due to the Monument's—and the Hanford Reach's—singular importance to the nation that the National Park Service (NPS), in a record of decision issued on July 16, 1996, recommended that the Hanford Reach and its surrounding lands be designated a recreational river in the NWSRS and that other lands in the area be designated a national wildlife refuge. While that designation has yet to be realized, on June 9, 2000, portions of the Hanford Site, including the Hanford Reach and associated islands, wildlife management areas to the north, White Bluffs, Hanford Dunes, ALE, and the McGee Ranch/Riverlands area, were designated as the Hanford Reach National Monument to be administered as part of the NWRS. Although the DOE currently owns the entire Monument, the FWS exercises management over 165,000 acres of the Monument, and the WDFW manages a small recreational access area.

3.1.1 Current Administrative Units

The Monument is currently divided into six administrative units (see Map 5). These units are artifacts from DOE management, delineated to fulfill their purposes. As noted in Chapter 2, new unit delineations are proposed, are based on biological and administrative needs, that meet the mission of the FWS. The existing administrative management units are described below.

3.1.1.1 Fitzner-Eberhardt Arid Lands Ecology Reserve

The 73,930-acre Fitzner-Eberhardt Arid Lands Ecology Reserve[48] lies in the southwest portion of the Monument in Benton County. The ALE was officially recognized as a valuable site for

[48] Richard Fitzner and Lester Eberhardt were two acclaimed sage grouse biologists, killed a plane crash while conducting aerial wildlife surveys. On November 30, 1993, Congress official renamed the area the "Fitzner-Eberhardt Arid Lands Ecology Area" in their honor.

scientific study in 1967 due to the rich and relatively undisturbed character of its native shrub-steppe ecosystem. The ALE was subsequently designated a federal RNA in 1971. The area has been managed for the DOE by the FWS since 1997. It is closed to public access but open for scientific research and educational purposes by special-use permit.

3.1.1.2 McGee Ranch/Riverlands Unit

The DOE manages this 9,096-acre unit to the north of the ALE. The unit lies entirely within Benton County and contains the biologically diverse Umtanum Ridge area and extensive native grasslands and shrublands, as well as powering corridors and highly degraded former agricultural lands, homesteads and town sites. There is no official public access, although the Riverlands area north of the Midway Substation Road has been subject to trespass for years.

3.1.1.3 Vernita Bridge Access Area

This small area (approximately 405 acres) on the Columbia River just north of the Vernita Bridge in Grant County has been managed by the WDFW since 1971, primarily to provide river access for fishing and boating.

3.1.1.4 Saddle Mountain Unit

This 30,981-acre unit borders the north shore of the Columbia River and is located entirely within Grant County. This unit of the Monument has been managed by the FWS since 1971. It contains sagebrush stands and important rare plant habitats, along with heavily disturbed former agricultural lands and the Saddle Mountain Lakes, a large area of irrigation wasteway impoundments. It provides good views to the B Reactor (see Section 3.20.6). The unit is bisected by State Route 24 but is otherwise closed to public access.

3.1.1.5 Wahluke Unit

The 58,034-acre Wahluke Unit, located primarily in Grant and Franklin Counties, is managed for public access (i.e, open to public use). This unit was managed by the WDFW from 1971 to 1999 and has been managed by the FWS since 1999. It includes most of the Monument's signature geologic feature—the White Bluffs—as well as significant shrub-steppe plant communities and rare plant habitats. The unit includes the Wahluke Branch Wasteway and associated impoundments, in particular the WB-10 Ponds.

3.1.1.6 River Corridor Unit

This 23,331-acre unit of the Monument includes the Hanford Reach of the Columbia River, along with the Columbia River islands and a 0.25-mile corridor along both the south and north shores of the river within Benton, Franklin and Grant Counties. The unit also contains the Hanford Dunes. Management of this unit is multi-jurisdictional, involving the DOE, FWS, Washington State Department of Natural Resources (WDNR), and several different state and county agencies.

3.2 Climate

The Monument lies in the semi-arid shrub-steppe Pasco Basin of the Columbia Plateau in southeastern Washington State. The region's climate is greatly influenced by the Pacific Ocean and the Cascade Mountain Range to the west and other mountain ranges to the north and east. The Pacific Ocean moderates temperatures throughout the Pacific Northwest, and the Cascade Range generates a rain shadow that limits rain and snowfall in the eastern half of Washington State. The Cascade Range also serves as a source of cold air drainage, which has a considerable effect on the wind regime on the Hanford Site. Mountain ranges to the north and east of the region shield the area from the severe winter storms and frigid air masses that move southward across Canada.

Climatological data for the Hanford Site are compiled at the Hanford Meteorology Station (HMS) located on Hanford's Central Plateau. Meteorological measurements have been taken at the HMS since late 1944. Prior to the establishment of the HMS, local meteorological observations were made at the Old Hanford Townsite (1912 through late 1943) and in Richland (1943 and 1944). A climatological summary for Hanford is provided in Hoitink et al. (2003).

Data from the HMS capture the general climatic conditions for the region and describe the specific climate of Hanford's Central Plateau. The large size of the Hanford Site and its complex topography give rise to substantial spatial variations in wind, precipitation, temperature and other meteorological parameters. An example of this is the marked differences in the annual distribution of wind directions and speeds measured at the HMS on the Central Plateau and at the 300 Area near the southeastern corner of the Hanford Site. To accurately characterize meteorological differences across the Hanford Site, the HMS operates a network of automated monitoring stations. These stations, which currently number thirty, are located throughout the Hanford Site and in neighboring areas. A 408-foot instrumented meteorological tower operates at the HMS. Most of the other network stations use short-instrumented towers about thirty-feet high. Data is collected and processed at each monitoring site, and key information is transmitted to the HMS every fifteen minutes. This monitoring network has been in full operation since the early 1980s.

For reporting purposes throughout this section the seasons are defined as follows:

- Winter—December through February
- Spring—March through May
- Summer—June through August
- Autumn—September through November

3.2.1 Wind

Prevailing wind directions near the surface in most of the Monument are from the northwest all months of the year, although winds from the northwest occur most frequently during the winter and summer. Winds from the southwest also occur frequently in the Monument, especially in the southeastern quadrant. During the spring and fall, there is an increase in the frequency of winds from the southwest and a corresponding decrease in winds from the northwest.

Monthly average wind speeds at fifty feet above the ground are lower during the winter months, averaging six to seven miles per hour (mph), and faster during the summer, averaging eight to nine mph. The fastest wind speeds in the Monument are usually associated with flow from the southwest. However, the summertime drainage winds from the northwest out of the Cascade Mountains frequently exceed thirty mph. The maximum speed of the drainage winds (and their frequency of occurrence) tends to decrease toward the southeast.

3.2.2 Temperature and Humidity

Monthly averages and extremes of temperature, dew point, and humidity are presented in Neitzel (2004). Based on data collected from 1946 through 2002, the average monthly temperatures on the Monument's lower levels range from a low of 31°F in January to a high of 76°F in July. The highest winter monthly average temperatures recorded were 44°F in February 1958 and February 1991, and the lowest average monthly temperature was 12°F in January 1950. The highest monthly average temperature recorded was 82°F in July 1985, and the lowest summer monthly average temperature was 63°F in June 1953.

Daily maximum temperatures in the Monument vary from an average of 35°F in late December and early January to 96°F in late July. There are, on average, fifty-two days during the summer months with maximum temperatures of 90°F, and twelve days with temperatures greater than or equal to 100°F. The greatest number of consecutive days on record with maximum daily

temperatures of 90°F is thirty-two. The record maximum temperature was 113°F, recorded on August 4, 1961, and again on July 13, 2002.

From mid-November through early March, the average daily minimum temperature is below freezing; the daily minimum in late December and early January is 21°F. On average, the daily minimum temperature drops to 0°F or below only three days per year; however, only about one winter in two experiences such low temperatures. The greatest number of consecutive days on record with minimum daily temperatures of 0°F or below is eleven. The record minimum temperature of -23°F was recorded on both February 1 and 3, 1950.

The annual average relative humidity in the Monument is 55%. It is highest during the winter months, averaging about 76%, and lowest during the summer, averaging about 36%. The annual average dewpoint temperature in the Monument is 34°F. In the winter, the dewpoint temperature averages about 27°F, and in the summer it averages about 43°F.

3.2.3 Precipitation

Average annual precipitation in the Monument's lower levels is 6.8 inches. In 1995, the wettest year on record, the precipitation measured was 12.3 inches; in 1976, the driest year, only 3.0 inches were measured. The wettest season on record was the winter of 1996–97, with 5.4 inches of precipitation; the driest season was the summer of 1973, with only 0.03 inches of precipitation. Most precipitation occurs during the late autumn and winter, with more than half of the annual amount occurring from November through February. Days with greater than 0.50 inches of precipitation occur on average less than once each year.

Average snowfall ranges from 0.1 inch in October to a maximum of 5.2 inches in December, decreasing to 0.5 inches in March. The record monthly snowfall of 23.4 inches occurred in January 1950. The seasonal record snowfall of 56.1 inches occurred during the winter of 1992–93. Snowfall accounts for about 38% of all precipitation from December through February.

3.2.4 Fog and Visibility

Fog has been recorded during every month of the year in the Monument; however, 89% of the occurrences are from November through February, with less than 3% from April through September. The average number of days per year with fog (visibility of six miles or less) is forty-eight; the average number of days with dense fog (visibility of 0.25 mile or less) is twenty-five. The greatest number of days with fog was eighty-four in 1985–86 and the least was twenty-two in 1948–49. The greatest number of days with dense fog was forty-two in 1950–51 and the least was nine days in 1948–49. The greatest persistence of fog was 114 hours in

December 1985, and the greatest persistence of dense fog was forty-seven hours in December 1957.

Other phenomena causing restrictions to visibility (i.e., visibility of six miles or less) include dust, blowing dust, and smoke from field burning. There are few such days; an average of five days per year have dust or blowing dust, and an average of less than one day per year has visibility reduced from smoke to less than six miles.

3.2.5 Severe Weather

Concerns about severe weather generally center on hurricanes, tornadoes and thunderstorms. Washington does not experience hurricanes, and tornadoes are infrequent and generally small in the northwestern part of the United States. The National Climatic Data Center maintains a database that provides information on the incidence of tornados reported in each county in the United States. This database reports that in the ten counties closest to the Monument (Adams, Benton, Franklin, Grant, Klickitat, Kittitas, Walla Walla and Yakima Counties in Washington, and Morrow and Umatilla Counties in Oregon), only twenty-two tornados have been recorded since 1950. Of these, fifteen tornadoes had maximum wind speeds estimated in the range of 40 to 72 mph, four had maximum wind speeds in the range of 73 to 112 mph, and three had maximum wind speeds in the range of 113 to 157 mph. There were no deaths or substantial property damage (in excess of $50,000) associated with any of these tornadoes.

For a five-degree block centered at 117.5° west longitude and 47.5° north latitude (the area in which the Monument is located), the expected path length of a tornado is five miles, the expected width is 312 feet, and the expected area is about one square mile (Ramsdell and Andrews 1986). The estimated probability of a tornado striking a point in the Monument is less than 0.0001% per year. However, the Monument could be affected by extreme winds generated by a nearby tornado.

On average, there are ten thunderstorms in the vicinity of the Monument per year. They are most frequent during the summer; however, they have occurred in every month. Thunderstorms can generate high-speed winds and hail. Using the National Weather Service criteria for classifying a thunderstorm as *severe* (i.e., hail with a diameter of 0.75 inch or greater or wind gusts of 58 mph), only 1.9% of all thunderstorm events surveyed in the Monument have been severe storms, and all met the criteria based on their wind gusts. High-speed winds in the Monument are more commonly associated with strong cold frontal passages. In rare cases, intense low-pressure systems can generate winds of near hurricane force.

3.3 Hydrology

Hydrology considerations in the Monument include surface water, groundwater, and the vadose zone. *Groundwater* refers to water within the saturated zone. The *vadose zone* is the unsaturated or partially saturated region between ground surface and the saturated zone; water there is called soil moisture. Permeable saturated units in the subsurface are called *aquifers*.

3.3.1 Surface Water

Surface water in the Monument includes the Columbia River, Columbia riverbank seepage, and springs and ponds, as well as runoff and flooding. Intermittent surface streams, such as Cold Creek, may also contain water after large precipitation or snowmelt events. There is also surface water associated with irrigation east and north of the Columbia River within the Monument. The Monument is adjacent to the Yakima River.

3.3.1.1 Columbia River

Originating in the Canadian Rockies of southeastern British Columbia, the Columbia River drains a total area of approximately 262,480 square miles on its 1,240-mile journey to the Pacific Ocean. Partly due to this large drainage and partly due to the abundant precipitation over much of its watershed, the Columbia River is the fourth largest river in the United States in terms of total flow (an estimated average discharge of 71,016 cubic feet per second), even though it is only the twelfth longest river in the country. Over much of its course, the river's flow is highly "unnatural," being heavily regulated by numerous dams.[49] Priest Rapids is the nearest upstream dam, and McNary is the nearest downstream dam on the Columbia River. Lake Wallula, the impoundment created by McNary Dam, extends upstream past Richland, Washington, to the southern part of the Monument. Except for the Columbia River estuary, the only unimpounded stretch of the river in the United States is the Hanford Reach, which extends from Priest Rapids Dam downstream approximately fifty-one miles to the McNary Pool north of Richland. The creation of the Monument was based, in part, on the fact that the Hanford Reach is a free-flowing stretch of the Columbia River.

[49] There are ten dams upstream of the Monument on the Columbia River, seven in the U.S. (Priest Rapids, Wanapum, Rock Island, Rocky Reach, Wells, Chief Joseph) and three in Canada (Keenleyside, Revelstone, Mica). Downstream of the Monument are four dams on the mainstem of the Columbia River (McNary, John Day, The Dalles, Bonneville) (see Map 14). This does not include the dozens, if not hundreds of dams on the Snake River and other tributaries in the Columbia River system.

Flows through the Hanford Reach can fluctuate significantly depending on the year, season and time of day. Seasonal and daily flows through the Hanford Reach are controlled primarily by releases from the large upstream storage dams, including Mica, Duncan and Keenleyside in Canada and Libby, Hungry Horse, and Grand Coulee in the United States. Grand Coulee, as the largest and most upstream development in the United States, establishes the daily flow regime through the mid-Columbia River and, ultimately, the Hanford Reach.

Generally speaking, these storage reservoirs are drawn down in the fall and winter to provide flood protection from peak river flows caused by rainstorms and snowmelt in the spring and refill by the end of the spring runoff. Coordination of these reservoir operations is carried out through regional forums established for that purpose, such as the Pacific Northwest Coordination Agreement and the Columbia River Treaty with Canada.

Hourly flows in the Hanford Reach are directly affected by releases from Priest Rapids Dam, which is owned and operated by the Grant County Public Utilities District. This dam is operated as one of a system of seven hydroelectric projects immediately upstream of Hanford Reach through the Mid-Columbia Hourly Coordination Agreement. The seven projects are owned and operated by federal agencies (BOR and ACOE in cooperation with the BPA) and three public utility districts (Douglas, Chelan and Grant Counties). The Grant County Public Utility District recently was issued a new license to operate the Priest Rapids Complex (Priest Rapids and Wanapum Dams) by the Federal Energy Regulatory Commission (FERC); the license sets the year-round Priest Rapids minimum flow at 36,000 cubic feet per second (cfs). However, from the time fall Chinook salmon spawning starts (typically sometime in October or November) through the emergence of fry in May, flows are targeted at 50,000 to 70,000 cfs as a result of the Hanford Reach Fall Chinook Protection Program.[50]

Natural flows in the Columbia River vary greatly on a seasonal basis but are typically stable over the short term because of the river's sheer size. Columbia River flows typically peak from April through June during spring runoff and are lowest from September through October. Flow rates near Priest Rapids during the eighty-six-year period from 1917 to 2003 averaged nearly 120,000 cfs. Daily average flows during this period ranged from 20,000 to 690,000 cfs. The lowest and highest flows occurred before the construction of upstream dams. During the ten-year period from 1993 through 2003, the average flow rate was also about 120,000 cfs.

As a result of daily fluctuations in discharges from Priest Rapids Dam, the depth of the river varies significantly over a short time. River stage changes of up to twelve feet during a twenty-four-hour period may occur along the Hanford Reach (Poston et al. 2000). Daily fluctuations (maximum to minimum flow) typically exceed 100,000 cfs about 25% of the time and are less

[50] The Hanford Reach Fall Chinook Protection Program was developed by federal and state agencies, public utility districts, and environmental organizations in an effort to establish a flow scenario that would protect spawning salmon and the resultant smolts.

than 50,000 cfs about 25% of the time. The width of the river varies from approximately 1,000 feet to 3,300 feet along the Hanford Reach. The width also varies temporally as the flow rate changes, which causes repeated wetting and drying of an area along the shoreline.

The primary uses of the Columbia River include the production of hydroelectric power, irrigation of cropland in the Columbia Basin, transportation of materials, residential and industrial water use, and recreation. The Hanford Reach is the upstream limit of barge traffic on the mainstem Columbia River. Barges are used to transport reactor vessels from decommissioned nuclear submarines to Hanford for disposal. Several communities located along the Columbia River rely on the river as their source of drinking water. The Columbia River is also used as a source of industrial water for several Hanford Site facilities (Dirkes 1993), particularly the nuclear reactor operated by Energy Northwest. Recreational uses include fishing, hunting, boating, sailboarding, water-skiing, diving and swimming. Storage reservoir operations are also conducted for the benefit of both resident and anadromous fish and play a major role in protecting the near-river developments from severe flooding.

3.3.1.2 Columbia Riverbank Seepage

The discharge of groundwater into the Columbia River has been known to occur for many years. Riverbank seeps were documented long before Hanford Site operations began (Jenkins 1922). In the early 1980s, researchers identified 115 springs along the Benton County shoreline of the Hanford Reach (McCormack and Carlisle 1984). Seepage occurs both below the river surface and on the exposed riverbank, particularly at low-river stage. The seeps flow intermittently, apparently influenced primarily by changes in river level. In many areas, water flows from the river into the aquifer at high river stages and then returns to the river at low river stages.

3.3.1.3 Yakima River

The Yakima River, which flows near the southwestern boundary of the Monument, has much lower flows than the Columbia River. The average flow, based on nearly sixty years of daily flow records, is about 3,712 cfs, with an average monthly maximum of 17,500 cfs and a minimum of 165 cfs. Exceptionally high flows were observed during 1996 and 1997. The highest average daily flow rate during 1997 was nearly 45,900 cfs. Average flow during 2000 was 3,176 cfs. The Yakima River System drains surface runoff from a portion of the Monument. Groundwater from the Monument does not reach the Yakima River and, because the elevation of the river surface is higher than the adjacent water table (based on well water-level measurements), groundwater is expected to flow from the Yakima River into the aquifer underlying the Monument, rather than from the aquifer into the river (Thorne et al. 1994).

3.3.1.4 Springs and Streams

Several springs are found on the slopes of the Rattlesnake Hills along the western edge of the Monument (DOE 1988). TNC, in its *Biodiversity Inventory and Analysis of the Hanford Site 1997 Annual Report* (Hall 1998), documented an alkaline spring at the eastern end of Umtanum Ridge. Rattlesnake and Snively Springs form small surface streams; water discharged from Rattlesnake springs flows down Dry Creek for about 1.6 miles before disappearing into the ground. While these springs are small, their impact on the Monument is huge; they provide water sources for a variety of wildlife and allow the growth of trees for songbird and raptor use as nest sites, sanctuaries and hunting perches.

3.3.1.5 Runoff and Net Infiltration

Due to the arid landscape, runoff and infiltration of precipitation is limited. The total estimated precipitation over the Pasco Basin is about 3,232 cubic feet annually (DOE 1988). Precipitation varies both spatially and temporally, with higher amounts generally falling at higher elevations. Annual precipitation measured at the Hanford Meteorology Station has varied from 3.0 inches to 12.3 inches since 1945. Most precipitation occurs during the late autumn and winter, with more than half of the annual amount occurring from November through February. Mean annual runoff from the Pasco Basin is estimated at less than twenty cubic feet per year (DOE 1988). Most of the remaining precipitation is lost through evapotranspiration. However, some precipitation that infiltrates the soil is not lost to evaporation or transpiration and eventually recharges the groundwater flow system.

Cold Creek and its tributary, Dry Creek, are ephemeral streams within the Yakima River drainage. When surface flow does occur, it infiltrates rapidly and disappears into the surface sediments in the western part of the Hanford Site.

3.3.1.6 Flooding

Large Columbia River floods have occurred in the past (DOE 1987) and were annual events prior to the era of dam construction. Major floods on the Columbia River are typically the result of rapid melting of the snowpack over a wide area augmented by above-normal precipitation. The maximum historical flood on record occurred June 7, 1894, with a peak discharge through the Hanford Reach of 742,000 cfs. The largest recent flood took place in 1948 with an observed peak discharge of 700,000 cfs through the Hanford Reach. While still possible, the probability of flooding at the magnitude of the 1894 and 1948 floods has been greatly reduced by the construction of numerous flood control/water-storage dams upstream of the Monument. For example, exceptionally high spring runoff in 1996 resulted in a maximum discharge of only

415,000 cfs, according to the United States Geological Survey (USGS; 2002). According to the ACOE (1989), the 100-year regulated flood for this part of the river is 440,000 cfs.

3.3.1.7 Non-Riverine Surface Water

Other than rivers and springs, there are no naturally occurring bodies of surface water on or adjacent to the Monument. However, there are artificial wetlands, caused by irrigation return, on the east and west sides of the Wahluke Slope, which lies north of the Columbia River. Hatcheries and irrigation canals constitute the only other artificial surface water in the Monument vicinity. The Ringold Hatchery is located just south of the Monument boundary on the east side of the Columbia River.

3.3.2 Vadose Zone

In the Hanford area, the thickness of the vadose zone ranges from zero feet near the Columbia River to more than 300 feet beneath parts of the Monument (estimated). Unconsolidated glacio-fluvial sands and gravels of the Hanford Formation make up most of the vadose zone. In some areas, however, the fluvial-lacustrine sediments of the Ringold Formation make up the lower part of the vadose zone.

Moisture movement through the vadose zone is important in and around the Monument because it is the driving force for migration of most contaminants to groundwater.

The major source of recharge to the vadose zone is natural precipitation. Natural infiltration in the vadose zone causes older, preexisting water to be displaced downward by newly infiltrated water. The amount of recharge at any particular site is highly dependent on the soil type and the presence of vegetation. Usually, vegetation reduces the amount of infiltration through the biological process of transpiration.

3.3.3 Groundwater

Groundwater beneath the Monument originated as either natural recharge from rain and snowmelt, or as artificial recharge from excess irrigation, canal seepage, and wastewater disposal. The groundwater will eventually return to the surface environment as discharge to springs and seepage into rivers and streams, through evaporation from shallow water table areas, or brought to the surface through wells or excavations. However, it may take many thousands of years for groundwater in deeper aquifers to reach the surface.

3.3.3.1 Monument Aquifer System

Groundwater beneath the Monument is found in both an upper unconfined aquifer system and deeper basalt-confined aquifers. The unconfined aquifer system is also referred to as the suprabasalt aquifer system because it is within the sediments that overlie the basalt bedrock. Portions of the suprabasalt aquifer system are locally confined. However, because the entire suprabasalt aquifer system is interconnected on a site-wide scale, it is considered an unconfined aquifer system.

3.3.3.1.1 Basalt-Confined Aquifer System

Relatively permeable sedimentary interbeds and the more porous tops and bottoms of basalt flows provide the confined aquifers within the Columbia River Basalts. Hydraulic-head information indicates that groundwater in the basalt-confined aquifers generally flows toward the Columbia River at various rates, depending on density and conductivity and, in some places, toward areas of enhanced vertical communication with the unconfined aquifer system (Hartman et al. 2001, DOE 1988). The basalt-confined aquifer system is important because there is a potential for significant groundwater movement between the two systems.

3.3.3.1.2 Unconfined Aquifer System

The unconfined aquifer system is composed primarily of the Ringold Formation and overlying Hanford Formation. In some areas, pre-Missoula gravels (distantly derived subunit) of the Plio-Pleistocene unit lie between these formations and below the water table. The other subunits of the Plio-Pleistocene unit are generally above the water table.

Groundwater in the unconfined aquifer at Hanford generally flows from recharge areas in the elevated region near the western boundary of the Monument toward the Columbia River on the eastern and northern boundaries. The Columbia River is the primary discharge area for the unconfined aquifer. The Yakima River borders the Monument on the southwest and is generally regarded as a source of recharge. Along the Columbia River shoreline, the daily river level fluctuations may result in water table elevation changes of up to ten feet. During the high river stage periods of 1996 and 1997, some wells near the Columbia River showed water level changes of more than ten feet. As the river stage rises, a pressure wave is transmitted inland through the groundwater. The longer the duration of the higher river stage, the farther inland the effect is propagated. The pressure wave is observed farther inland than the water actually moves. For the river water to flow inland, the river level must be higher than the groundwater surface and must remain high long enough for the water to flow through the sediments. Typically, this inland flow of river water is restricted to within several hundred yards of the shoreline (McMahon and Peterson 1992).

Estimated groundwater recharge rates from precipitation range from near zero to over 0.001 inches per year (Gee et al. 1992, Fayer et al. 1996). Recharge is highly variable both spatially and temporally. It is highest for coarse-textured soils bare of deep-rooted vegetation and in years with rapid snowmelt events and precipitation during cool months. The magnitude of recharge at a particular location is influenced by five main factors—climate, soils, vegetation, topography and springs and streams. Events such as the 24 Command Fire that burned vegetation from a large portion of the Monument in 2000 also affect recharge rates.

3.3.3.2 Groundwater Residence Times

Tritium and carbon-14 measurements indicate that residence or recharge time (length of time required to replace the groundwater) takes tens to hundreds of years for spring waters. Recharge takes from hundreds to thousands of years for the unconfined aquifer and more than 10,000 years for groundwater in the shallow confined aquifer (Johnson et al. 1992). However, because of large volumes of recharge from wastewater that was disposed on the Hanford Site between 1944 and the mid-1990s, and the relatively high permeability of Hanford Formation sediments, groundwater travel time on parts of the Monument to the Columbia River has been shown to be much faster, in the range of ten to thirty years (USGS 1987, Freshley and Graham 1988). Residence times in this portion of the aquifer are expected to increase because of the reduction in wastewater recharge. Chlorine-36 and noble gas isotope data suggest groundwater ages greater than 100,000 years in the deeper confined systems (Johnson et al. 1992). These relatively long residence times are consistent with semiarid-site recharge conditions.

3.3.4 Hydrology East and North of the Columbia River

Groundwater in the northern and eastern portions of the Monument is affected by high artificial recharge from irrigation and canal leakage of irrigation water out of the Columbia Basin Project. Areas north and east of the Monument are irrigated by the SCBID, and return flows, both surface and groundwater, occur in the Monument. Artificial recharge has increased water table elevations in large areas of the Pasco Basin, in some places by as much as 300 feet (Drost et al. 1989).

There are two general hydrologic areas that impinge on the Monument boundaries to the east and north of the river. The eastern area extends from north to south between the lower slope of the Saddle Mountains and the Esquatzel Diversion Canal and includes the Ringold Coulee, White Bluffs area, and Esquatzel Coulee. The water table occurs in the Pasco gravels of the Hanford Formation in both Ringold and Esquatzel Coulees. Runoff from spring discharge at the mouth of Ringold Coulee is greater than 10,000 gallons per minute. Elsewhere in this area, the unconfined aquifer is in the less-transmissive Ringold Formation. Irrigation has also created perched aquifers, resulting in a series of springs along the White Bluffs. The increased hydraulic

pressure in these sediments has caused subsequent slumping and landslides (Brown 1979, Newcomer et al. 1991).

The other principal irrigated area is the northern part of the Pasco Basin on the Wahluke Slope, which lies between the Columbia River and the Saddle Mountain anticline. Irrigation on the Wahluke Slope has created ponds and seeps in the Saddle Mountain Unit. The direction of unconfined groundwater flow is southward from the basalt ridges toward the Columbia River.

3.4 Environmental Contaminants

For more than forty years, the primary mission of the Hanford Site was the production of weapons-grade plutonium for the United States nuclear arsenal. The vast infrastructure associated with that mission on the Hanford Site comprised nine nuclear reactor sites along the Columbia River, plutonium separation plants on the central plateau to the south, and fuel fabrication and research facilities near the city of Richland. Tremendous quantities of wastes were generated during this production era, the storage and disposal of which resulted in contamination of the surrounding environment, including some lands within the Monument.

Today, the Hanford Site mission focuses on treatment and disposal of these legacy wastes. The DOE is obligated to comply with various laws that pertain to the environmental cleanup and closure of the Hanford Site, including the CERCLA, Resource Conservation and Recovery Act (RCRA), Clean Water Act (CWA), and several state regulations. The cleanup schedule and process is regulated by the Hanford Federal Facility Agreement and Consent Order (signed May 15, 1989; also referred to as the Tri-Party Agreement or TPA). Three regulatory agencies are involved in this comprehensive cleanup and compliance agreement—DOE, EPA and Washington Department of Ecology (WDOE). Specifically, the TPA is intended to accomplish the following cleanup-related actions.

- Define and rank CERCLA and RCRA cleanup commitments.
- Establish responsibilities.
- Provide a basis for budgeting.
- Maintain a concerted goal of achieving full regulatory compliance and remediation with enforceable milestones.

The FWS is also involved in Hanford Site cleanup issues through its role as a member of the Hanford Natural Resource Trustee Council (HNRTC). The general objectives of the HNRTC are to help ensure that natural resource values are fully considered in decisions related to the

Hanford Site (including Monument lands); to integrate, to the extent practicable, natural resource restoration into remedial actions; to minimize resource injury during remedial action; to encourage the development and implementation of site-wide natural resource planning which supports mitigation, restoration and management goals and encompasses good stewardship practices; and to provide the DOE and regulatory agencies the information necessary to achieve the above objectives. The HNRTC consists of trustee agencies and governments with authority under the CERCLA to seek legal damages for injury to natural resources at Hanford. The HNRTC trustees include BLM, DOE, FWS, Oregon Department of Energy, WDOE, WDFW, CTUIR, Nez Perce Tribe, and Yakama Nation. The HNRTC is working with the DOE and other agencies to help provide ecological and other input in support of site remediation and cleanup.

Much of what is now considered Monument land once served as a buffer around the core areas of the Hanford Site. Few activities were allowed on these buffer lands, and consequently they contain large amounts of ecologically valuable and, in some instances, near-pristine habitat. The DOE still "owns" all Monument lands. Transfer of lands within the Monument boundaries to the DOI (i.e., FWS) is possible, but only uncontaminated land can be transferred. DOI policy requires a pre-acquisition survey to determine the suitability of any land proposed for transfer into the NWRS (e.g., is the land clean enough to support refuge [Monument] purposes).[51]

Based on existing or future actions and management plans from the DOE, Energy Northwest (a commercial nuclear power reactor operating on the Hanford Site), the state of Washington, and/or local counties, exclusion zones or emergency response zones associated with the Hanford Site may overlap some of the Monument lands. Wherever necessary, the FWS will either restrict access or ensure that those individuals using affected portions of the Monument will be advised of emergency procedures and comply with all requirements of those plans.

Cleanup activities at the Hanford Site are scheduled to continue for at least two to three decades, which is beyond the expected span of this CCP.

See Sections 3.5, "Air Quality," and 3.6, "Water Quality," for additional information on the environmental quality of the Monument.

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[51] There are numerous issues associated with land transfer. An important condition of the transfer process ensures that the DOE remain legally and fiscally responsible for any of its legacy wastes that might be discovered on transferred lands in the future. This responsibility includes the costs associated with long-term monitoring and any future cleanup actions that may become necessary on any Monument lands. Post-remediation monitoring of formerly contaminated areas and periodic reviews to determine the efficacy of the remediation efforts are required by law. Based on decisions by and advice from the TPA, it may be necessary to advise against or otherwise restrict activities related to hunting, fishing, other recreational activities, or gathering of plants on some areas of the Monument. There are numerous isolated patches of land within the Monument that supported military or other site-related missions, and at least some of these areas will most likely require additional cleanup or will be excluded from the transfer package. All of these issues, and the land transfer process itself, are the responsibility of the DOE to address, and the DOE will address all analysis necessary under the NEPA through other documentation. It should be noted that not all land transfers require NEPA analysis.

3.5 Air Quality

3.5.1 State of Washington Air Quality

The Clean Air Act is the basis for federal regulation of air quality in the United States. While the EPA sets national ambient air quality standards, the states have the primary responsibility for ensuring that air quality within the state meets the national standards. This is done through state plans that are approved by the EPA.[52]

State and local governments have the authority to impose stricter standards for ambient air quality than the national standards, and the state of Washington has established more stringent standards for sulfur dioxide. In addition, Washington has established standards for total suspended particulates and fluorides that are not covered by national standards. The state standards for carbon monoxide, nitrogen dioxide, small particulates, and lead are identical to the national standards.

All but one area in Washington (the Wallula area located approximately twenty miles southeast of the Monument does) meets the federal health-based clean air standards, and air quality in Washington has been steadily improving. The number of days Washington violated air quality standards has seen a dramatic decrease, from 150 days in 1987 to seven days in 1999 (the last data available). In addition, the number of people in Washington exposed to air that violates federal standards has dropped from a high of more than two million people in 1990 to about 112,000 people in 1999.

The main sources of air pollution in Washington are, in order, motor vehicles, industry, wood stoves and fireplaces, and outdoor burning. Other sources include lawnmowers, boats and recreational vehicles, aircraft and trains. Although the sources have remained largely the same over the years, the amount of air pollution they contribute has shifted. For example, in 1991 motor vehicles caused 43% of Washington's air pollution, and industrial emissions were responsible for 25%. Wood stoves contributed 20% and outdoor burning 10%. In 1999 emission percentage estimates indicated a significant increase in air pollution from motor vehicles (57%) and a decline in pollution caused by industry (17%), wood stoves (11%), and outdoor burning (5%). This shift may be due to several factors. For example, Washington has

[52] Ambient air quality standards define levels of air quality that are necessary, with an adequate margin of safety, to protect the public health (primary standards) and the public welfare (secondary standards). *Ambient air* is that portion of the atmosphere, external to buildings, to which the general public has access. The EPA has issued ambient air standards for sulfur oxides (measured as sulfur dioxide), nitrogen dioxide, carbon monoxide, lead, ozone and small particles with an aerodynamic diameter less than or equal to ten micrometers. Particulate matter is a federally regulated pollutant; in high concentrations, it poses a health risk to both sensitive and healthy populations.

grown, more people are driving, air pollution control technologies for industry have improved, fewer people heat their homes with wood, and outdoor burning is allowed in fewer areas.

3.5.2 Monument Air Quality

Compared to other areas of Washington State, the Monument has some of the cleanest air over the majority of the year. The Benton Clean Air Authority conducts air monitoring that is responsible for determining Benton County's compliance with the EPA National Ambient Air Quality Standards. The WDOE provides this service for Adams, Franklin and Grant Counties through its Eastern Regional Office. All four counties, and subsequently the Monument, are in attainment for all state and federal standards. Average pollution levels are well below the national average. However, particulate concentrations can reach relatively high levels in eastern Washington because of exceptional natural events (i.e., dust storms and large brush fires) that occur in the region. On occasion, the Monument experiences problems with particulate matter. The primary sources of particulate matter over the Monument include activity-related and wind-blown dust from construction and agriculture; wind-blown dust from open lands; agricultural burning; and wildfires. Other minor sources (impacting the Monument) include wood-burning stoves and fireplaces, industrial sources, and motor vehicles.[53]

While air quality on the Monument is generally good, there are concerns regarding chemical and radiological pollutants. The DOE and WDOE, as well as the Benton County Clean Air Authority, have extensive monitoring systems in place to check for both types of pollutants. For example, during the last ten years, carbon monoxide, sulfur dioxide, and nitrogen dioxide have been monitored periodically in communities and commercial areas southeast of the Hanford Site. These urban measurements are typically used to estimate the maximum background pollutant concentrations for the Hanford Site. For a full discussion of these potential pollutants, monitoring systems, and results refer to the *Hanford Site National Environmental Policy Act Characterization* (Neitzel 2004) and the *Hanford Site Environmental Report for Calendar Year 2003* (DOE 2004).

3.6 Water Quality

The CWA and the Washington Water Pollution Control Act provide the statutory basis for the regulation of water quality in Washington State. The CWA established the National Pollutant

[53] In June 1996, the EPA adopted the policy that allows dust storms to be treated as uncontrollable natural events. This means that EPA will not designate areas affected by dust storms as non-attainment. However, states are required to develop and implement a natural events action plan.

Discharge Elimination System (NPDES) to limit the amount of pollutants that could be discharged into waterways. The EPA has not delegated the authority to issue NPDES permits at the Hanford Site to the state of Washington. However, WDOE regulations have established a state permit program for the discharge of waste materials from industrial, commercial and municipal operations into ground and surface waters of the state.

The CCP and this EIS focus on management of the Monument. Numerous DOE, EPA and WDOE publications deal with water contamination on the Hanford Site and its cleanup. For a full discussion of contaminants and their remediation, visit the DOE's web site (www.hanford.gov) or one of the DOE public information repository locations.

3.6.1 Columbia River

Washington State has designated the water quality of the Columbia River from Grand Coulee Dam to the Washington-Oregon border, which includes the Hanford Reach, as Class A, Excellent (DOE 2003a). Class A waters are suitable for essentially all uses, including raw drinking water, primary-contact recreation, and wildlife habitat. State and federal drinking water standards apply to the Columbia River; EPA drinking water standards apply to Columbia River water at community water supply intakes downstream of the Hanford Site. These standards apply indirectly to contaminants from DOE facilities (and also non-DOE facilities) to the extent that water releases affect community water systems.

During 2002, the USGS measured several water quality parameters at the Vernita Bridge, upstream of the Monument, and at the Richland Pumphouse, downstream of the Monument. Total dissolved solids, total dissolved nitrogen, and dissolved oxygen measured near the Monument during 2002 were well within EPA and state standards. There were no statistically significant differences between upstream and downstream samples for these parameters (Poston et al. 2005).

The Pacific Northwest National Laboratory (PNNL) measured both radiological and non-radiological constituents in Columbia River water during 2002 as part of a continuing environmental monitoring program (Poston et al. 2003). Cumulative water samples are collected at Priest Rapids Dam and at the Richland Pumphouse. Additional samples were taken at transects of the river and at near-shore locations at the Vernita Bridge, 100-F Area, 100-N Area, the Hanford Town sites, and the 300 Area. These water samples were collected at frequencies varying from quarterly to annually. These data show a statistical increase in tritium, nitrate, uranium and iodine-129 along the Hanford Reach. All these constituents are known to be entering the river from contaminated groundwater beneath the Hanford Site. Measurements of strontium-90 at the Richland Pumphouse were not statistically higher than those at the Vernita Bridge, even though strontium-90 is known to enter the river through groundwater inflow at 100-N Area. Measurements of tritium along transects showed higher concentrations near the

shoreline relative to mid-river for samples from the 100-N Area, Hanford Town sites, 300 Area, and Richland Pumphouse.

Other sources of pollutants entering the river are irrigation return flows and groundwater seepage associated with irrigated agriculture. The USGS (1995) documented nitrate groundwater contamination in Franklin County, which also seeps into the river along the Hanford Reach. However, in spite of pollutants introduced from the Hanford Site and other sources, dilution in the river results in contaminant concentrations that are below drinking water standards (Poston et al. 2003).

3.6.2 Springs and Seeps

The quality of water of the non-riverine springs in the Monument varies depending on the source. However, they are all up-gradient of Hanford waste sites and groundwater contamination plumes, so water quality is generally quite good. This is not the case with many of the Columbia riverbank springs. In areas of contaminated groundwater, riverbank springs are also generally contaminated. However, contaminant concentrations in seeping water along the riverbank may be lower than in groundwater because of the bank-storage phenomenon (see Section 3.3.1.2). Contaminants have been detected in near-shore samples downstream from riverbank springs (Poston et al. 2003). Riverbank springs are monitored for radionuclides at the 100-N Area, Hanford Town sites, and 300 Area. Hanford Site contaminants occur in some of these springs (Peterson and Johnson 1992, Poston et al. 2003); detected radionuclides include strontium-90; technetium-99; iodine-129; uranium-234, -235, and -238; and tritium. Other detected contaminants include arsenic, chromium, chloride, fluoride, nitrate and sulfate. Volatile organic compounds were below detection limits.

3.6.3 Other Surface Water

There are two other surface water sites within the Monument—the Saddle Mountain Lakes and the WB-10 Ponds. Both are the result of irrigation return ponding. Little is known about contaminants in these water bodies; however, it is likely that any contamination present would be either wind-borne or carried in with irrigation return flows. The BOR is planning to sample the WB-10 Ponds in 2005. See Section 3.16.4 for a discussion of irrigation water contaminants.

3.6.4 Groundwater

Due to decades of industrial and agricultural use in the area of the Hanford Site, groundwater contaminants are present under parts of the Monument, most notably along the south shore of

the Columbia River. Many of these contaminant plumes are well documented by the DOE; others are in the process of being documented. In any event, the process and responsibility of identifying and cleaning these contaminants lies with other agencies. For additional discussion of groundwater contamination and the NEPA processes involved, see Section 3.4.

The FWS will continue to work with the DOE, EPA and WDOE to ensure that the public using the Monument will not be harmed by groundwater contaminants. Essential to the protection of public health is the DOE's extensive monitoring program. Radiological and chemical components in groundwater at the Hanford Site are monitored to characterize physical and chemical trends in the flow system, establish groundwater quality baselines, assess groundwater remediation, and identify new or existing groundwater problems. Groundwater is also monitored to verify compliance with applicable environmental laws and regulations. Samples are collected from approximately 700 wells to determine the distributions of radiological and chemical constituents in Hanford Site groundwater. Detailed results and interpretations are presented in Hartman et al. (2001).

3.6.4.1 Natural Groundwater Quality

The quality of natural groundwater at the Hanford Site varies depending on the aquifer system and depth, which generally is related to residence time in the aquifer. Groundwater chemistry in the basalt-confined aquifers displays a range, depending on depth and residence time (DOE 1988). The chemical type varies from a calcium and magnesium-carbonate water to a sodium- and chloride-carbonate water. Some of the shallower basalt-confined aquifers in the region (e.g., the Wanapum basalt aquifer) have exceptionally good water quality characteristics (Johnson et al. 1992). However, deeper basalt-confined aquifers typically have high dissolved solids content and some have fluoride concentrations over the drinking water standard (DOE 1988).

3.6.5 Vadose Zone

The Hanford Site has more than 800 past-practice liquid-disposal facilities. Radioactive liquid waste was discharged to the vadose zone—the unsaturated or partially saturated region between ground surface and the saturated zone—through reverse (injection) wells, French drains, cribs, ponds, trenches and ditches. Most effluent was released in the 200 Areas which are remote from the Monument; approximately 280 unplanned releases in the 200 Areas also contributed contaminants to the vadose zone that ultimately connects to the Monument near the Columbia River shoreline through groundwater transport (DOE 1997b). Many of these were from underground tanks that leaked and have contributed contamination to the vadose zone. In addition, approximately fifty active and inactive septic tanks and drain fields and numerous radioactive and non-radioactive landfills and dumps have affected the vadose zone (DOE 1997b). The landfills are, and were used to, dispose of solid wastes, which, in most instances,

are easier to locate, retrieve and remediate than are liquid wastes. During Hanford Site operations, cooling water from the single-pass reactors in and just outside the Monument along the Columbia River was routinely routed to retention basins in the 100 Area prior to return to the river. Thermal shock from the hot cooling water cracked the basins so that much of the cooling water leaked into the vadose zone. In addition, trenches were used for disposal of cooling water from several reactors. Contaminated cooling water that had contacted broken fuel rods was routed to trenches rather than being directly returned to the river, further contaminating the vadose zone. The amount of contamination remaining in the vadose zone is unknown.

3.7 Geology and Geomorphology

3.7.1 Geologic History

Geologic history, with spectacular landscapes exhibiting the power of nature, was a significant contributing element in the establishment of the Monument. The Monument lies within the geologic area known as the Columbia Basin and contains all its main geologic elements (DOE 1988).[54] Four major events formed most of the earth (the soil and rocks) and geologic features (ridges and valleys) of the Columbia Basin and therefore the Monument.

1) The area was flooded with numerous basaltic lava flows.

2) Tectonic forces in the Earth folded the basalt.

3) In this landscape, the ancestral Columbia River meandered across the area, leaving behind layers of sediment called the Ringold Formation.

4) The last, and most recent, event—the Missoula Floods—ended 10,000 years ago after the area was inundated by a series of floods (the Missoula Floods), which left more sediment in what is informally called the Hanford Formation.

3.7.1.1 Lava Flows

Lava flows erupted from cracks in the earth over a period from seventeen to six million years ago, spreading over Idaho, Oregon and Washington. Under the Monument, these basaltic lava

[54] The Columbia Basin is the area bounded by the Cascade Range to the west, the Rocky Mountains to the northeast, and the Blue Mountains to the southeast.

deposits (called the Columbia River Basalt Group) are over 13,000 feet thick (Reidel and Hooper 1989). Although the Columbia River Basalt Group is one of the smallest flood-basalt areas, the individual lava flows that comprise the area are some of the largest found on Earth. Within the area covered by the Columbia River Basalt Group are two distinct subbasins, each having its own geologic character—the Columbia Basin and Pasco Basin.

3.7.1.1.1 Columbia Basin

This basin encloses the Columbia River Basalt Group, which is surrounded by the Cascade Mountains to the west, Rocky Mountains to the northeast, Blue Mountains to the southeast. The Columbia Basin lies mostly in southeastern Washington but also extends into western Idaho and northern Oregon.

3.7.1.1.2 Pasco Basin

This is a depression in the lower part of the Columbia Basin and is bounded by the Saddle Mountains to the north, Naneum Ridge to the west, the Rattlesnake Hills to the south, and the Palouse Slope to the east—generally the area north of where the Snake River flows into the Columbia River. The ridges surrounding the Pasco Basin are the result of the tectonic forces. Geographically, however, the ridges surrounding the Monument and vicinity define what is known as the Pasco Basin. The Pasco Basin is filled with Ringold sediment from the ancestral Columbia River and sediment left by the Missoula Floods. The Hanford Site comprises the southern portion of the Pasco Basin, occupying over 586 square miles.

3.7.1.2 Tectonic Forces

After the lava flows had cooled and hardened, the earth's tectonic forces buckled and folded the basalt in the western Columbia Basin into generally east-west trending, long, narrow ridges called anticlines and intervening valleys called synclines. Collectively, geologists call this series of ridges and valleys in the western Columbia Basin the Yakima Fold Belt.

3.7.1.3 Ancestral Columbia River

The ancestral Columbia River repeatedly changed its course over the past fifteen million years and left deposits of gravel, sand, silt and clay (Tallman et al. 1981; Reidel et al. 1994). The deposits were the result of the ancestral river's growing restriction in the low areas of the Pasco Basin and lower Yakima Valley as the rising ridges of basalt grew. These processes changed the course of the Columbia River from a southerly direction (toward Yakima and Goldendale)

to an easterly direction (toward Wallula Gap) and left behind the Ringold Formation (Fecht et al. 1987). Later, regional uplift in the western United States caused the river to cut through its own earlier deposits (the Ringold Formation), exposing the Monument's signature White Bluffs.

Today the Columbia River continues its erosion. The force that first exposed the White Bluffs is now wearing away its base. Groundwater, along with irrigation water seeping into the ground from northeast of the bluffs, makes them unstable. The result is the White Bluffs are sliding and sloughing into the Columbia River, giving back its ancestral deposits (Fecht et al. 1987).

3.7.1.4 Missoula Floods

The last major geologic event to shape the Monument was the Missoula Floods. During the freezes and thaws that occurred in the last Ice Age—the Wisconsin—an ice dam across the Clark Fork River in Montana formed and failed many times, each time releasing a wall of water that surged southwest through the Columbia Basin, inundating most of the Monument several hundred feet deep.[55] The largest and most frequent floods came from glacial Lake Missoula in northwestern Montana. However, smaller floods may have escaped down-valley from glacial lakes Clark and Columbia along the northern margin of the Columbia Basin (Waitt 1980) or down the Snake River from glacial Lake Bonneville (Malde 1968).

The Missoula Floods began as early as one million years ago (Bjornstad and Fecht 1989), with the most recent occurring around 13,000–15,000 years ago. The Missoula Floods inundated the Monument several times, beginning as early as one million years ago (DOE 1988). The last major flood sequence is dated at about 13,000 years ago. The floods affected the landscape in different ways. As the water moved across eastern Washington, it eroded the basalt, forming channels of barren rocky land referred to as the channeled scabland. At other localities, such as away from the main flood channels, the water deposited massive bars of sand and gravel in only a few days. Where the water ponded behind obstacles such as Wallula Gap, it left behind deposits of silt known as the Touchet Beds.

When the floodwaters entered the Pasco Basin, they quickly became impounded behind solid basalt in the Wallula Gap, which was too restrictive for the volume of water involved. This temporary, reoccurring glacial lake is known as Lake Lewis. Lake Lewis is estimated to have had a surface area of approximately 4,500 square miles and to have reached a depth of about 900 feet. In the Monument, the elevation of the lake level at times rose to 1,200 feet, which

[55] The floods are of such national interest that the NPS is currently in the process of establishing the Ice Age Floods Trail, which will link together existing local, state and federally sites, facilities and attractions into a "partnership" park that can be driven from point to point to tell the story of the floods and their impact on the Pacific Northwest. To find out more, please visit www.nps.gov/iceagefloods/.

corresponds to the 1200 Foot Road near the toe of Rattlesnake Mountain. The lakes lasted no more than a few weeks (Baker 1978).

Since the end of the Missoula Floods, winds have reworked the deposits of sand and silt left behind, shifting them into dune sands in the lower elevations and loess (windblown silt) around the margins of the Pasco Basin. Anchoring vegetation has stabilized many sand dunes. Where human activity has disturbed this vegetation, dunes have been reactivated. More recently, dunes have been reactivated by the removal of vegetation resulting from the 24 Command Fire (June–July 2000).

3.7.2 Landmass Elements

The Hanford Site today is a composite of what the lava flows, tectonic forces, river changes, and Missoula Floods of long ago left behind and the winds have since reshaped. The resulting landmass elements that affect, and are affected by, activities in the Monument are its physical and structural characteristics, the strata and structure of its rocks, and its potential for earthquakes.

3.7.2.1 Physical and Structural Characteristics

The Monument is basically defined by the Palouse Slope and Yakima Fold Belt (DOE 1988). The rock of the Palouse Slope dips gently toward the central Columbia Basin and exhibits relatively mild structural deformation. A wedge of Columbia River basalt underlies the Palouse Slope, thinning gradually toward the east and north and lapping onto the adjacent highlands.

The Yakima Fold Belt is the name collectively given to all the ridges formed from the basaltic lava flows that are found in the central and western parts of the Columbia Basin. They are a result of tectonic forces compressing the basaltic lava flows and overlying sediment into a series of anticlines (ridges) and synclines (valleys). The five main ridges and valleys on the Monument are described below.

- The Saddle Mountains are the ridge that forms the northern boundary of the Pasco Basin and Monument. The Saddle Mountains are an east-west ridge about sixty-eight miles long and three miles wide.

- The Wahluke Slope is on the north side of the Columbia River. The Wahluke Slope is the trough (syncline) of basalt between the Saddle Mountains and Umtanum Ridge.

- Umtanum Ridge is the ridge that makes up the south boundary of the Wahluke Slope.

- The Rattlesnake Hills-Rattlesnake Mountain lie south and west of the Monument and are also the result of a fold of arched rock layers. The highest of the hills, Rattlesnake Mountain, reaches an elevation of 3,660 feet above mean sea level, making it the highest elevation in the area.

- The Cold Creek syncline is the folded trough of rock that lies between Umtanum Ridge and Yakima Ridge. The Yakima Ridge is one of the anticlines of the Yakima Fold Belt. The Cold Creek Bar, a deposit of Missoula Floods sediment, lies in this area along the northwest boundary.

3.7.2.2 Rock Strata and Structure

Beneath the Monument, the bedrock formation comprises a minimum of 100 basalt flows with a combined thickness of almost 13,000 feet (DOE 1988), all part of the Columbia River Basalt Group.

To organize the many deposits of basalt into a consistent nomenclature, geologists have named and grouped them based on their properties. The basalt deposit closest to the surface on the Monument, and therefore the one most often referred to, is the Saddle Mountains Basalt. The Saddle Mountains Basalt consists of ten distinct basaltic lava deposits (referred to as *members*). The most recent basalt flow underlying most of the Monument is called the Elephant Mountain Member of the Saddle Mountains Basalt.

In addition to basalt, the Monument also has sedimentary rock formations. Some of the sedimentary rock on the Monument is found between the basaltic lavas and is called the Ellensburg Formation. However, the majority of the sediment is above the basalt in a stacked column with the Ringold Formation on the bottom, overlain by the Cold Creek Unit, and topped with a formation not formally named but called the Hanford Formation; these sediments overlie the Columbia River Basalt Group. The formations that comprise the stacked column are primarily exposed in lower elevation areas around the Monument, such as at the White Bluffs.

3.7.2.2.1 Ellensburg Formation

The Ellensburg Formation is the name applied to all sediment that is found interbedded with the Columbia River Basalt Group. The Ellensburg Formation formed as long as seventeen million years ago, although the youngest portion on the Monument may have formed as recently as eight million years ago. The Ellensburg Formation was created when volcanic rock and sediment of eroded volcanic rock from the Cascade Range and Rocky Mountains interfingered with the basalt of the Columbia River Basalt Group (Swanson et al. 1979). The thickest accumulations of the Ellensburg Formation lie along the western margin of the Columbia Basin. While

deposition along the western margin was primarily from volcanic debris flows and related stream and sheet floods, no volcanic debris flows have been identified on the Monument (Reidel et al. 1994). Volcanic rock formed from falling ash (tuff) is the dominant material in the Monument portion of the Ellensburg Formation. The Ellensburg Formation is exposed along the ridges of the Yakima Fold Belt.

3.7.2.2.2 Ringold Formation

The Ringold Formation formed between eight and three million years ago when the ancestral Columbia River left deposits of gravel, sand, silt and clay (Tallman et al. 1981; DOE 1988; Lindsey 1996).[56] Although exposures of the Ringold Formation are limited to the White Bluffs within the Monument, extensive data on the Ringold Formation are available from boreholes. The Ringold Formation on the Monument is over 600 feet thick. The subsurface sediment next to the basalt bedrock is dominated by gravel and forms most of the lower half of the Ringold Formation. The middle part of the Ringold Formation is dominated by sand deposits. Lake deposits dominate the upper layer of the Ringold Formation (DOE 1988).

3.7.2.2.3 Cold Creek Unit

The Cold Creek Unit includes all material underlying the Hanford Formation and overlying the Ringold Formation (DOE 1988) and is found locally in the Cold Creek syncline. The Cold Creek Unit distinguishes itself from the Hanford and Ringold Formations because it exhibits a time when the Ringold Formation was being eroded and very little was being deposited. Distribution of the Cold Creek Unit depends in part on erosion of the underlying Ringold Formation and post-depositional erosion by the Missoula Floods (Slate 1996). The thickness of the Cold Creek deposits ranges from zero to sixty-six feet. The top of the Cold Creek Unit is composed of a very hard rock that formed as precipitation evaporated and left behind minerals, forming what geologists call *caliche* or *hardpan*.

3.7.2.2.4 Hanford Formation

The Hanford Formation is the informal name for the rock strata and structure that lie on top of the Cold Creek Unit above the Ringold Formation. As the Missoula floods inundated the Monument and then receded, massive deposits were left behind, blanket low-lying areas over most of the Monument and are informally called the Hanford Formation. Gravel, sand and silt (Touchet Beds) dominate the Hanford Formation (Reidel et al. 1992); the relative proportion of

[56] There is some debate if these sediments are actually from an ancestral Columbia River. Other suggested sources include the Clearwater/Salmon drainage system in Idaho or the Pend Oreille River in northeastern Washington.

each material at any given location is related to its distance from main high-energy flows at the time of deposition (DOE 1988).

3.7.2.2.5 Clastic Dikes

Clastic dikes are fissures filled with sand, silt, clay and minor coarser debris. They are commonly associated with, but not restricted to, Missoula Floods deposits in the Columbia Basin. Many dikes occur as sharp-walled, near-vertical tabular bodies filled with multiple layers of unconsolidated sediment. Thin clay/silt linings separate the margins of dikes and internal layers (Fecht et al. 1999). Dikes vary in width from less than 0.039 inches to more than 6.5 feet and in length from less than 3.0 feet to more than 164.0 feet (Fecht et al. 1999).

3.7.2.3 Surface Soils

Soils on the Monument have not been fully mapped; the area north of the Columbia River still needs considerable cataloging work. However, the work completed to date has identified and described the following fifteen different soil types, varying from sand to silty and sandy loam, on the Hanford Site (Hajek 1966).

1) *Ritzville silt loam.* This is a dark-colored silt loam soil found midway up the slopes of the Rattlesnake Hills. It develops under bunch grass from silty wind-laid deposits mixed with small amounts of volcanic ash. Characteristically more than sixty inches deep, Ritzville silt loam may be separated by bedrock occurring between thirty and sixty inches.

2) *Rupert sand.* This is one of the most extensive soil types on the Hanford Site. It develops under grass, sagebrush, and hopsage in coarse sandy alluvial deposits mantled by wind-blown sand. Rupert sand is a brown to grayish-brown coarse sand, grading to dark grayish-brown at a depth of thirty-five inches. Rupert sand forms hummocky terraces and dune-like ridges.

3) *Hezel sand.* Similar to Rupert sand, Hezel sand is a laminated, grayish-brown, strongly calcareous silt loam subsoil usually encountered within thirty-nine inches of the surface. Where it occurs as a surface soil, it is very dark brown. Hezel sand is formed in wind-blown sands that mantle lake-laid sediment.

4) *Koehler sand.* Koehler sand is similar to other sandy soils found on the Hanford Site, but it differs in that it mantles a lime-silica cemented hardpan layer. It develops in a wind-blown sand mantle and exhibits a very dark grayish-brown surface layer, somewhat

darker than Rupert sand. Its calcareous subsoil is usually dark grayish-brown at about eighteen inches.

5) *Burbank loamy sand.* This is a dark-colored, coarse-textured soil underlain by gravel. Its surface soil is usually about sixteen inches thick but may be as much as thirty inches. The gravel content of its subsoil ranges from 20% to 80%.

6) *Ephrata sandy loam.* Ephrata sandy loam is found on level topography on the Hanford Site. Its surface is darkly colored, and its subsoil is a dark grayish-brown, medium-textured soil underlain by gravelly material that may continue for many feet.

7) *Lickskillet silt loam.* This soil is found on the ridge slopes of the Rattlesnake Hills and on slopes higher than 2,509 feet. It is similar to Kiona silt loam except the surface soil is darker. Lickskillet silt loam is shallow over basalt bedrock and exhibits numerous basalt fragments throughout the profile.

8) *Ephrata stony loam.* Ephrata stony loam is similar to Ephrata sandy loam. It differs in that many large hummocky ridges comprise debris released from melting glaciers. Areas of Ephrata stony loam located between hummocks contain numerous boulders several feet in diameter.

9) *Pasco silt loam.* Pasco silt loam is a poorly drained, very dark grayish-brown soil formed in recently deposited alluvial material. Its subsoil is variable, consisting of stratified layers. Only small areas of Pasco silt loam are found on the Hanford Site, all in low areas adjacent to the Columbia River.

10) *Kiona silt loam.* Kiona silt loam is found on steep slopes and ridges. Its surface soil is very dark grayish-brown and about four inches thick. Its subsoil is dark brown and contains basalt fragments twelve inches and larger in diameter. Many basalt fragments are found in its surface layer, and basalt rock outcrops are often present. Kiona silt loam is a shallow, stony soil normally occurring in association with Ritzville and Warden soils.

11) *Warden silt loam.* This is a dark grayish-brown soil with a surface layer usually around nine inches thick. Its silt loam subsoil becomes strongly calcareous at about twenty inches and becomes lighter colored. Granitic boulders are found in many areas. Warden silt loam is usually deeper than sixty inches.

12) *Scootney stony silt loam.* Scootney stony silt loam develops along the north slope of the Rattlesnake Hills and is usually confined to floors of narrow draws or small fan-shaped areas where draws open onto plains. It is severely eroded, with numerous basaltic boulders and fragments exposed. The surface soil is usually dark grayish-brown grading to grayish-brown within the subsoil.

13) *Esquatzel silt loam.* Esquatzel silt loam is a deep dark-brown soil, forming in recent alluvium derived from loess and lake sediment. Its subsoil grades to dark grayish-brown in many areas, but the color and texture of the subsoil is variable because of the stratified nature of the alluvial deposits.

14) *Riverwash.* Riverwash comprises wet, periodically flooded areas of sand, gravel and boulder deposits that make up overflowed islands in the Columbia River and adjacent land.

15) *Dune sand.* Dune sand is a miscellaneous land type that consists of hills or ridges of sand-sized particles drifted and piled up by wind. These dunes are either actively shifted or so recently fixed or stabilized that no soil layers have developed.

3.7.3 Seismic Activity

The recorded history of earthquakes in the Pacific Northwest dates from about 1840; the early record is probably incomplete because the region was sparsely populated (the early history is based on human perceptions of earthquakes). Seismograph networks did not start providing earthquake locations and magnitudes in the Northwest until about 1960. A comprehensive network of seismic stations that provides accurate locating information for most earthquakes of magnitude greater than 2.5 (Richter Scale) was not installed in eastern Washington until 1969.

While large earthquakes (magnitude 7.0 or greater) occur in the Pacific Northwest, they are rare in the seismically stable interior Columbia Basin. A significant large earthquake (estimated at magnitude 7.4) did occur in north-central Washington in 1872; evidence of landslides near Lake Chelan suggests a location near there. The largest known earthquake in the Columbia Plateau occurred in 1936 near Milton-Freewater, Oregon. This earthquake had a magnitude of 5.75 and was followed by a number of aftershocks indicating a northeast-trending fault plane. Other earthquakes with magnitudes of 5.0 or greater occurred along the boundaries of the Columbia Plateau in a cluster near Lake Chelan in 1872 and extending into the northern Cascade Range, in northern Idaho and Washington, and along the boundary between the western Columbia Plateau and the Cascade Range. Other large earthquakes in the Columbia Basin occurred in the Milton-Freewater, Oregon, region in 1921; near Yakima, Washington, in 1892; and near Umatilla, Oregon, in 1893. In the central portion of the Columbia Plateau, the largest earthquakes near the Monument occurred in 1918 and 1973. These two events had magnitudes of 4.4 and were located north of the Monument near Othello.

Small earthquakes often occur in spatial and temporal clusters in the central Columbia Plateau and are termed *earthquake swarms*. The region north and east of the Monument is a region of concentrated earthquake swarm activity, but earthquake swarms have also occurred in several locations within the Monument. The frequency of earthquakes in a swarm tends to gradually

increase and decay with no one outstanding large event within the sequence. Roughly 90% of the earthquakes in swarms have magnitudes of 2.0 or less. These earthquake swarms generally occur at shallow depths, with 75% of the events located at depths of less than 2.5 miles. Each earthquake swarm typically lasts several weeks to months and consists of several to 100 or more earthquakes. The locations are typically clustered in an area from three to six miles in lateral dimension. Detailed locations of swarm earthquakes indicate that the events occur on fault planes of variable orientation rather than on a single, through-going fault plane.

Although rare, earthquakes in the central Columbia Plateau do occur to depths of about eighteen miles. These deeper earthquakes are less clustered and occur more often as single, isolated events. Based on seismic refraction surveys, the shallow earthquake swarms are occurring in the Columbia River Basalts, and the deeper earthquakes are occurring in crustal layers below the basalts. The pattern of seismicity in the central Columbia Plateau suggests an association of the shallow swarm activity with the east-west oriented Saddle Mountains anticline.

3.7.4 White Bluffs Landslides

The White Bluffs along the Columbia River are the signature visual feature of the Monument; unfortunately, they are also the most endangered feature. Over the past two decades, the natural erosion rate has been greatly accelerated, in all likelihood due to irrigation waters from the Central Columbia Basin Irrigation Project saturating soils that are naturally unstable. The sediments comprising the White Bluffs are from an ancestral river and are nearly two miles wide within the Monument. These sediments are unconsolidated silts and sands, which promote the percolation of water until an impermeable stratum captures the flow and causes it to seep out, causing extreme slope instability, deep fissures, and water-filled pockets.

In 2003, a study/consolidation of existing information was funded through the Center for Conflict Resolution. Triangle Associates, a Seattle-based consulting firm, interviewed experts in the field, elected officials, agricultural and environmental interests, state and federal agency personnel, Native American representatives, and others in an effort to determine the extent of the problem and the concerns of those affected by the sloughing. Triangle Associates also conducted an extensive literature review on the landslides and held three workshops on geology, groundwater and irrigated agriculture, and the impacts of the landslides to fish and aquatic and riparian habitats. All of this information was consolidated into an assessment report published in March 2003. Of singular importance was the conclusion that the geologic and hydrologic processes at work are poorly understood and that additional study is needed to adequately address the problem. The USGS currently has a proposal pending for this additional research.

Apart from the obvious damage to a unique geologic feature, sloughing of the White Bluffs has several other impacts. Although exposure of the Ringold Formation and fossil localities is a useful aspect of the landslide for geologists and paleontologists, these resources are being lost

to the river with every landslide. While all the slides are detrimental, the most prominent and controversial slide is the one above Locke Island. Here, continual hydration of the fragile sediments has resulted in the slide of an estimated twelve million cubic yards of sediment into the modern-day river channel. The movement of the landslide into the river has forced the river to shift its flow, eating into Locke Island and eroding cultural sites on the island. Other impacts from the landslides include siltation of salmon redds. Sloughing threatens the rare White Bluffs bladderpod, which grows along the cliff edges. The Savage Island slide (ten million cubic yards) is located near the Ringold area, an area of heavy public use, raising concerns over public safety due to unstable soils and deep, water-filled pockets.

3.7.5 Special Geologic Features of the Monument

Several unique or special geologic features are found on the Monument. World-renowned bedrock basalt flows have ridge features (known as *wrinkle ridges*) analogous to those on Mars and possibly other portions of the solar system. Sand dunes are located in various parts of the Monument, the result of reworked Pleistocene flood deposits being driven by high winds in the Columbia Basin. The dunes on the Monument are predominantly parabolic, although barchan and transverse dunes appear. The most notable dune field, located in the southeast corner of the Monument, was specifically included as part of the Monument in order to protect this unique geological phenomenon. These active, primarily unvegetated dunes range from ten to sixteen feet high, can cover several hundred acres, and migrate in an east to northeast direction at a rate of eight to fifteen feet per year. Various other dunes can be identified within the Monument landscape. The top of the White Bluffs have a well-known field with both migrating dunes on the bluff edge and stabilized dunes to the east. Smaller dune areas are located within the ALE. Movement and stability varies depending on natural factors (fire, wind, vegetation) and human intervention (surface disturbance). For example, the 2000 fire in the ALE denuded the area, reactivating dunes which previously were protected from erosion by vegetative cover.

In addition to leaving behind sand to form dunes, the Missoula Floods contributed several other geologic features to the Monument. Glacial erratics are non-indigenous rocks, such as granitics, gneiss, quartzite, argillite and schist, carried on ice rafts by the raging flood waters from as far away as Montana and Idaho. These rocks, often reaching boulder size, are scattered around the Monument, up to the highest lake levels reached, about 1,200 feet on the flanks of Rattlesnake Mountain. Other unique features connected to the floods are bergmounds, giant ripple marks, and gravel bars. All of these features are considered slack water deposits that occur when turbulent water action subsides. The southwestern end of the Monument contains such topographic high points because the northern base of Rattlesnake Mountain was the periphery of the lake. The ripples and gravel bars are formed primarily of sand and gravel carried along by the sheer power of the flood waters. As the water was slowed by natural features, such as the Wallula Gap, or the floods naturally receded, the scouring power of the water was reduced, and the sands and gravels were deposited out. Like erratics, bergmounds were left when icebergs

rafted lithic material from other areas. Bergmounds are typically composed of small gravels of the same materials as erratics but are found at slightly lower elevations, usually below 1,000 feet. It is believed that bergmounds were formed when larger icebergs grounded themselves at the shallow edges of the lake as the flood waters withdrew. Being larger and deeper, they hit bottom sooner than those carrying the erratic boulders. Once grounded, the ice melted, depositing the iceberg's load of sand and gravel in place.

3.8 Paleontological Resources

One of the major landmarks within the Monument, the White Bluffs, is the middle component of the Ringold Formation, which dates to between three and eight million years ago. The formation is composed of a 1,000-foot thick deposit of interbedded lacustrine and fluvial silts, sands and conglomerate, with some paleosol remnants. The source of the sediments is unknown, although ideas about their origination include the Clearwater/Salmon drainage system from Idaho, the Pend Oreille River in northeastern Washington, and an ancestral Columbia River.

Regional uplifting about three million years ago resulted in the present upper Columbia River down cutting through about 600 feet of the Ringold Formation to its present elevation of 300 feet. This last erosional event has exposed a multitude of vertebrate and some invertebrate fossils in the Ringold Formation. Of particular note are rhinoceros and anadromous salmonid fossils from the late Miocene.

The subsequent White Bluffs component of the formation contains even more fossils, including twenty-seven species of mammals alone. Among the fauna found are rodents, lizards, frogs, turtles, fish, rabbits, bears, canids, cats, ground sloths, peccaries, deer, mastodons, camels, horses and zebras. Of particular interest is the nature of the fish species found (primarily warm-water species such as catfish and sunfish) and those not found (salmonids), supporting the theory of two separate river systems during the Miocene. The river system responsible for the White Bluffs deposit may not have been connected to the Pacific Ocean, hence the lack of anadromous fish remains.

In addition to the fossils found in the White Bluffs, petrified wood can be found in the Saddle Mountains, Umtanum Ridge, and Yakima Ridge. Scatterings of petrified wood can also be found in the Dry Creek and Cold Creek drainages. It should be noted that the collection of fossils is prohibited on the Monument.

3.9 Plants and Plant Communities

The term *plant communities* refers to plant species that coexist in generally recognizable groups. Plant communities are important indicators of biodiversity because they form the biotic component of the habitat used by other organisms. Plant community surveys were conducted as part of the biodiversity inventory over the entire Hanford Site, excluding only areas off-limits because of radiological hazards.

Plant communities are classified at one or more of three levels.

- Potential plant community type.
- Vegetation mapping unit.
- Cover type.

Potential plant community types reflect the plant species that are projected to dominate an undisturbed site over time, based on climate and other abiotic factors present at the site. A potential plant community type generally is identified by both its dominant shrub (when present) and dominant grass (or grasses when shrubs are absent).

Vegetation mapping units identify the existing vegetation of an area. Vegetation mapping unit types are grouped into more generalized cover types. The conservation significance of each area mapped is determined, using criteria developed by the WNHP, by an assessment (ranking) of ecological condition, size and the surrounding landscape. Vegetation mapping units that meet minimum biodiversity standards are designated "element occurrences" and will be entered into the WNHP tracking system for significant state- and region-wide elements of biodiversity. (As used here, an *element* is an entire biological system, such as a plant community or a wetland ecosystem.) Cover types are the plant communities that currently exist on site.

The diversity and vast size of native plant communities found in the Monument and Central Hanford is unmatched in the ecoregion. Biodiversity inventory personnel and the WNHP identified a total of seventeen terrestrial potential plant community types (or elements) that occur as forty-eight separate element occurrences in the Wahluke, Saddle Mountain, and ALE Units (see Maps 15 and 16). Only three of the seventeen identified terrestrial plant community elements are common to the ALE, Wahluke Slope, and Central Hanford. The terrestrial element occurrences cover approximately 90,000 acres, occupying significant amounts of the ALE and Wahluke Slope and lesser, though substantial, acreages within Central Hanford.

The condition and size of the big sagebrush/bluebunch wheatgrass community in the ALE and the bitterbrush/Indian ricegrass and big sagebrush/needle-and-thread dune complex occurrences on the Wahluke Slope and Central Hanford are extensive and of particular regional importance.

(See Table 3.1 at the end of Section 3.10 for scientific names.) Additionally, the inventory identified six riparian wetland communities along the southern (western) shore of the Hanford Reach as element occurrences. Such communities are rare elsewhere along a river system that is otherwise a series of lakes.

Although Daubenmire (1970) placed the Hanford Site within the big sagebrush/bluebunch wheatgrass vegetation zone, the site spans a wide climatic and edaphic (soil) range, resulting in equally diverse vegetation. Much of Central Hanford and the Wahluke Slope is drier than typical big sagebrush/bluebunch areas, receiving six to eight inches or less of precipitation per year and having sandy or coarse textured soils. Under these conditions, bluebunch wheatgrass grows poorly or not at all. At the other extreme, the more cool and moist (mesic) conditions with loamy soil at high elevation on Rattlesnake Ridge are typical of the three-tip sagebrush/Idaho fescue zone (Daubenmire 1970). This range of climatic variation, combined with equally diverse geologic and soil conditions, has produced a remarkable diversity of potential plant community types. Thus, while the big sagebrush/bluebunch wheatgrass community represents the climatic climax plant community expected to occur in the area (i.e., the plant community predicted to occur on deep loamy soils in areas with a gentle slope, moderate drainage, and average chemical characteristics), other community types dominate over much of Central Hanford, the Wahluke Slope, and portions of the ALE. For the most part these are edaphic (soil-related) climax communities, dominated in the grass layer by needle-and-thread, Indian ricegrass, and Sandberg's bluegrass (more the result of low precipitation than soil type in some cases).

Natural plant communities have been altered by Euro-American activities, resulting in the proliferation of non-native species. A total of 727 species, representing ninety families of vascular plants, have been recorded for the Hanford Site (Sackschewsky and Downs 2001). Of this total, 179 are non-native species. Cheatgrass is the dominant non-native species. It is an aggressive colonizer and has become well established across the Hanford Site (Rickard and Rogers 1983). Hanford Site plants are adapted to low annual precipitation (6.8 inches), low water-holding capacity of the rooting substrate (sand), dry summers, and cold winters—situations that are ideal for cheatgrass.

Before settlement, the Hanford Site landscape lacked trees, although the Columbia River shoreline and natural springs supported a few scattered cottonwoods and willows. Homesteaders planted trees in association with agricultural areas. Shade and ornamental trees were also planted around former military installations and industrial areas in the Hanford Site. Currently, approximately twenty-three species of trees occur in the Monument. The most common species are black locust, Russian olive, cottonwood, willow, mulberry, sycamore and poplar. Many of these non-native species are aggressive colonizers and have become established along the Columbia River (e.g., mulberry, cottonwood, poplar, Russian olive), serving as a functional component of the riparian zone. For example, trees provide nesting habitat and cover for many species of mammals and birds. The 24 Command Fire negatively affected many shrubs and trees

associated with streams and springs in the ALE; however, these species are recovering rapidly (see Map 17).

TNC (Soll et al. 1999) conducted plant surveys in the ALE, Wahluke Slope, Central Hanford, and riparian communities along the Columbia River shoreline from 1994 through 1997. These surveys tentatively identified thirty potential terrestrial plant communities. Designation as a potential community indicates the type of community that would exist in an area if it were free of disturbance. In addition to characterizing potential plant communities, TNC found 112 populations/occurrences of twenty-eight rare plant taxa in the Hanford Site (Soll et al. 1999). When combined with observations preceding the 1994–1999 inventory, a total of 127 populations of thirty rare plant species have been documented in the Hanford Site.

Range fires that historically burned through the area during the summers eliminate fire intolerant species (e.g., big sagebrush) and allow more opportunistic and fire-resistant species a chance to become established. Recovery of burned areas is a slow process, and it will be many years before areas will reestablish the natural component of vegetation and associated animal life.

The plants listed in Table 3.1 will be discussed in the sections that follow.

Table 3.1. Plant Species Discussed in Chapter 3.

Common Name	***Scientific Name***
Antelope bitterbrush	*Purshia tridentata*
Alkali bulrush	*Scirpus maritimus*
Alkali saltgrass	*Distichlus stricta*
Aristulate lipocarpha (aka Awned halfchaff sedge)	*Lipocarpha aristulata*
Basalt milk-vetch	*Astragalus conjunctus* var. *rickardii*
Big sagebrush	*Artemisia tridentata*
Black cottonwood	*Populus trichocarpa*
Black greasewood	*Sarcobatus vermiculatus*
Bluebunch wheatgrass	*Agropyron spicata*
Bristly pectocarya (aka Bristly combseed)	*Pectocarya setosa*
Broadleaf cattail	*Typha latifolia*
Bulbous bluegrass	*Poa bulbosa*
Canadian (aka American or Common) waterweed	*Elodea canadensis*
Carey's balsamroot	*Balsamorhiza careyana*
Cattail species	*Typhus* spp.
Chaffweed	*Centunculus minimus*
Cheatgrass	*Bromus tectorum*
Columbia milkvetch	*Astragalus columbianus*
Columbia River mugwort	*Artemisia lindleyana*
Common spikerush	*Eleocharis palustris*
Coyote tobacco	*Nicotiana attenuata*

Common Name	*Scientific Name*
Crested wheatgrass	*Agropyron cristatum*
Cusick's bluegrass	*Poa cusickii*
Desert cryptantha (Miner's candle)	*Cryptantha scoparia*
Desert dodder	*Cuscuta denticulata*
Desert evening primrose	*Oenothera caespitosa var. caespitosa*
Duckweed species	*Lemna* spp.
Dune scurfpea	*Psoralidium lanceolatum*
Douglas' buckwheat	*Eriogonum douglasii*
Dwarf evening primrose (aka Dwarf suncup)	*Camissonia pygmaea*
Eurasian milfoil	*Myriophyllum spicatum*
False pimpernel	*Lindernia anagallidea*
Flatsedge species	*Cyperus* spp.
Flatspine burr ragweed	*Ambrosia acanthicarpa*
Fuzzytongue penstemon (aka Fuzzy beardtongue)	*Penstemon eriantherus* var. *whitedii*
Geyer's milkvetch	*Astragalus geyeri*
Giant wildrye (aka Great Basin wildrye)	*Elymus cinereus*
Gray cryptantha	*Cryptantha leucophaea*
Grayball sage	*Salvia dorrii*
Green rabbitbrush	*Chrysothamnus viscidiflorus*
Grey rabbitbrush	*Chrysothamnus nauseosus*
Greater Canadian St. John's wort	*Hypericum majus*
Hoover's desert-parsley	*Lomatium tuberosum*
Indian hemp (aka Common dogbane)	*Apocynum cannabinum*
Indian ricegrass	*Oryzopsis hymenoides*
Loeflingia	*Loeflingia squarrosa* var. *squarrosa*
Lowland toothcup	*Rotala ramosior*
Lupine species	*Lupinus* spp.
Mat mudwort (aka Southern or Owyhee mudwort)	*Limosella acaulis*
Narrowleaf willow (aka Coyote willow)	*Salix exigua*
Needle-and-thread (grass)	*Stipa comata*
Needle spikerush	*Eleocharis acicularis*
Northern wormwood	*Artemisia campestris* spp. *borealis*
Persistentsepal (aka Columbia) yellowcress	*Rorippa columbiae*
Piper's daisy	*Erigeron piperianus*
Pond weed species	*Potamogeton* spp.
Poplar species	*Populus* spp.
Prairie junegrass	*Koeleria cristata*
Purple loosestrife	*Lythrum salicaria*
Reed canarygrass	*Phalaris arundinacea*
Rock buckwheat	*Eriogonum sphaerocephalum*
Rosy calyptridium (aka Rosy pussypaws)	*Calyptridium roseum*

Common Name	*Scientific Name*
Russian olive	*Elaeagnus angustfolia*
Russian thistle	*Salsola kali*
Rush species	*Juncus* spp.
Salt sage	*Atriplex nuttallii* var. *falcata*
Sand dropseed	*Sporobolus cryptandrus*
Sand gilia (aka Great Basin gilia)	*Gilia leptomeria*
Sandberg's bluegrass	*Poa sandbergii*
Scarlet ammannia (aka Grand redstem)	*Ammannia robusta*
Shining (aka Slender) flatsedge	*Cyperus bipartitus*
Small-flower annual paintbrush	*Castilleja exilis*
Small-flower evening primrose	*Camissonia minor*
Small-flowered nama (aka Purplemat)	*Nama densum* var. *parviflorum*
Snake River cryptantha	*Cryptantha spiculifera*
Snow buckwheat	*Eriogonum niveum*
Spike rush species	*Eleocharis* spp.
Spiny hopsage	*Grayia spinosa*
Stiff sagebrush	*Artemisia rigida*
(Gray) Suksdorf's monkey-flower	*Mimulus suksdorfii*
Tamarisk (aka Salt cedar)	*Tamarix parviflora*
Thickspike wheatgrass	*Agropyron dasystachyum*
Three-tip sagebrush	*Artemisia tripartita*
Thyme desert buckwheat	*Eriogonum thymoides*
Umtanum desert buckwheat	*Eriogonum codium*
Wanapum crazyweed	*Oxytropis campestris* var. *wanapum*
Western goldentop	*Solidago occidentalis*
Western lilaeopsis	*Lilaeopsis occidentalis*
White Bluffs bladderpod	*Lesquerella tuplashensis*
White eatonella	*Eatonella nivea*
White mulberry	*Morus alba*
Willow species	*Salix* spp.
Winged combseed	*Pectocarya linearis* var. *penicillata*
Winterfat	*Eurotia lanata*
Yakima milkvetch	*Astragalus conjunctus* var. *reventiformis*
Yellow starthistle	*Centaurea solstitialis*

3.9.1 General Description by Management Area

Each existing management area in the Monument is characterized by a unique assemblage of plant communities. Although there are commonalties among management areas, each area has features or combinations of features not found on the others. A total of twenty-one different

upland plant community types and three found in riparian areas or along the Hanford Reach, ranging in total coverage from two to 84,000 acres, have been identified. A total of 91,637 acres of seventeen different types qualify as element occurrences.

3.9.1.1 ALE

One human-made and eighteen natural plant communities, ranging in size from two to 29,360 acres, have been identified and mapped in the ALE. The nineteen potential communities were composed of twenty-eight cover types. A total of 45,570 acres are in an ecological condition suitable for listing as element occurrences.

In general, ecological condition in the ALE improves with increasing elevation and more northerly aspects; the ALE has the largest expanses of loamy soils and north-facing aspects in the Monument. Plant communities above roughly 900 feet in elevation support the largest contiguous expanses of high-quality shrub-steppe in the Monument and the single largest element occurrence of high-quality bluebunch wheatgrass grassland in the Columbia Basin. Big sagebrush/bluebunch wheatgrass and three-tip sagebrush/bunchgrass communities cover more than 40,000 unbroken acres. The crest of Rattlesnake Mountain supports high-quality, low-growing lithosol communities on the shallow rocky soil. While also ecologically valuable, the lower elevation areas are dominated by generally lower-quality big sagebrush/Sandberg's bluegrass and big sagebrush/cheatgrass. Element occurrences of winterfat/Sandberg's bluegrass, black greasewood/alkali saltgrass, and a small occurrence of bitterbrush/dune complex at lower elevations add to the diversity and uniqueness of the site.

Two major spring systems, Snively and Rattlesnake, cross the western half of the site. These provide important aquatic and riparian habitats in an otherwise arid landscape.

The most ecologically important element occurrences in the ALE are the large big sagebrush/ bluebunch wheatgrass and three-tip sagebrush/bluebunch wheatgrass or Idaho fescue communities that cover nearly 40,000 contiguous acres on Rattlesnake Mountain. Other element occurrences of note include more than 1,000 acres of winterfat/Sandberg's bluegrass on the lower slopes of Rattlesnake Mountain, the big sagebrush/Sandberg's bluegrass occurrences on the flats in the Dry and Cold Creek Valleys, the willow riparian complex associated with the springs and creeks, and a degraded but uncommon example of black greasewood/saltgrass.

3.9.1.2 Wahluke Slope (Wahluke and Saddle Mountain Units)

The Wahluke Slope supports forty cover types of sixteen unique potential plant communities, including two resulting from human activities. Total coverage of each plant community ranges from a low of four to a high of nearly 59,000 acres. Six types found on the Wahluke Slope do

not occur to any great extent in the ALE. A total of 15,595 acres qualify as element occurrences, including representations of four types not found in the ALE.

Except on the predominantly south-facing slope of the Saddle Mountains, the Wahluke Slope is dominated by sandier soils than the ALE. Vegetation spans a continuum from open sand dunes with sparse vegetation above the White Bluffs to loamy soil with big sagebrush communities high on the Saddle Mountain crest. There are no natural springs or lakes on the Wahluke Slope, but irrigation runoff has created several large, artificial wetlands that diversify the habitats available to wildlife in this area.

A human use history—more intense than at the ALE—that includes farming, livestock grazing, and military training, has left its mark on the Wahluke Slope in the form of large areas dominated by cheatgrass. The Wahluke Slope contains, and buffers from surrounding agriculture, the Hanford Reach, including the spectacular, unique and fragile White Bluffs with their unique caliche soils. (The vegetation of the Hanford Reach is discussed separately below.) The most notable plant communities on the Wahluke Slope are large expanses of big sagebrush/needle-and-thread grass (5,681 acres), antelope bitterbrush/Indian ricegrass dune complex (9,314 acres), and spiny hopsage/Sandberg's bluegrass (1,161 acres) found on the flats above the White Bluffs. Large areas of big sagebrush/Sandberg's bluegrass on the lower slopes of the Saddle Mountains are also noteworthy.

Significant element occurrences exist within each of the community types. Because these types generally occur on potentially arable soils, extensive occurrences have been converted to agricultural uses almost everywhere else they once existed.

3.9.1.3 Riverlands/McGee Ranch

In 1996, additional inventory work was conducted on that portion of the Hanford Site that is located to the north and west of State Route 24 and south of the Columbia River (James and Soll 1996). This approximately 8,970-acre area—designated the McGee Ranch/Riverlands Unit—is dominated by the eastern portion of Umtanum Ridge. Umtanum Ridge is of particular conservation interest because, of all the east-west corridors in central Washington, it spans the widest variety of climate and vegetation zones. Umtanum Ridge runs west from the Central Plateau of the Hanford Site, through the Yakima Training Center and state-managed wildlife areas, to the foothills of the Cascade Mountains. It is a key physiographic feature that links the best remaining examples of shrub-steppe habitat in the state of Washington. This area also helps connect the ALE to the Columbia River and Wahluke Slope.

The condition of the plant communities in the Riverlands ranges from poor to good. The predominant potential plant community types present include big sagebrush/bluebunch wheatgrass, big sagebrush/needle-and-thread, big sagebrush/Sandberg's bluegrass, and stiff

sagebrush/Sandberg's bluegrass. Most of the communities in poorer condition are associated with the gentle south-facing slopes of Umtanum Ridge that had been heavily grazed and patchily burned in the past. Two areas qualified as element occurrences. The steep slopes on the north side of Umtanum Ridge support a big sagebrush/bluebunch wheatgrass potential plant community type in good condition. In the midst of this element occurrence, there is a second community, a stiff sagebrush/Sandberg's bluegrass potential plant community type that also is in good condition in places. The status of these areas needs to be reevaluated because, after the inventory was completed, a fire originating from the Yakima Training Center burned much of the McGee Ranch/Riverlands in late August 1996.

3.9.1.4 Hanford Reach

Eight riparian and three island upland community/cover types are identified in the Hanford Reach, including six occurrences of significant low-elevation wetlands. The assemblage of plant species changes from the river edge upward through the shoreline profile. The communities are clearly defined in some areas. In others, ecotones may be blurred due to hydrology, topography, overlapping habitat requirements, and susceptibility to invasion by weedy species. These factors combine to create shifting mosaics of species, most pronounced low in the riparian profile. Plant communities are identified to the degree practicable. Where dominant species are not confined to a specific zone, each zone is characterized by its physical features.

Although the Hanford Reach is free-flowing, changes in its hydrology from upstream dams have likely altered some riparian communities and substrates. For example, much of the substrate previously mapped as sand (ACOE 1976) is now cobble. Thus, some communities may reflect a transient state. Because data is lacking to describe successional pathways, only the existing vegetation is described.

Six areas along the south shore and islands of the river are identified as significant occurrences of Columbia Basin low-elevation riparian wetlands—China Bar, Islands 2–5, Locke Island, White Bluffs Slough, 100-F Area Slough, and the Hanford Town sites Slough. Although not all of these sites are pristine, such wetlands are of statewide conservation importance because most comparable sites have been permanently flooded by the reservoir system.

3.9.2 Microbiotic Crusts

Throughout much of the shrub-steppe region, a living crust covers some or all of the soil between plants. This soil crust—referred to as microbiotic, cryptobiotic, or cryptogamic—is composed of algae, fungi, lichens and mosses. Microbiotic soil crusts are especially well developed in relatively undisturbed areas, such as occur in portions of the Monument. More than ten species of organisms can be present on as little as 0.8 square-inches of soil. As a unit,

these assemblages are often compact and fragile. Although the ecological role of the microbiotic crust is not well understood, it clearly plays an important role in shrub-steppe ecosystem functions by reducing erosion, contributing nitrogen and organic carbon to the soil, and increasing infiltration of precipitation into the soil. Intact crusts can also enhance native seedling establishment in arid ecosystems (St. Clair et al. 1984), and the presence of intact biological crusts may inhibit the establishment of cheatgrass and other invasive species (Belnap et al. 2001, Kaltenecker et al. 1999).

The presence of a biological soil crust can influence the surface hydrology of a site. In many sites, it appears that infiltration rates increase with the presence of a crust, although this depends on a number of factors, including soil type, crust composition, and climate.

Lichens, bryophytes, cyanobacteria and green algae in the crust fix atmospheric carbon, contributing to the overall productivity of a plant community. Free-living cyanobacteria and many lichens in the crust are capable of fixing atmospheric nitrogen, which is subsequently released into the soil and used by vascular plants and fungi, contributing to enhanced productivity (Belnap et al. 2001; Evans and Belnap 1999). In some cases, vascular plants that grow in areas of well-developed crust have higher accumulations of essential plant nutrients than in sites that lack a crust (Belnap et al. 2001; Ridenour and Calloway 1997).

Most biological soil crusts are fragile and readily disturbed, with susceptibility to disruption related in part to site factors such as soil type, local climate, and the vascular plant community (Belnap et al. 2001; Ponzetti et al. 2003). Over the past century, most biological crusts in the Pacific Northwest have been heavily altered and sometimes destroyed by livestock, agricultural practices, wildfire, invasive species, and off-road vehicle use. There is evidence that the biological soil crusts in the Pacific Northwest, including those in the area of the Monument, evolved in low-disturbance environments, where impacts by large herbivores and fire were much less severe than at present.

An early study of microbiotic crust looked at seventeen sites representing a wide range of plant associations, ecological conditions, and soil types in the lower elevation portions of the Hanford Site. That study identified thirty soil lichen and eight moss species; three of the lichen species had not previously been described.

However, comparison with data from other studies conducted in shrub-steppe indicates that the Monument supports an even more diverse and unique crust flora. A recent study conducted in cooperation with TNC biological diversity inventories found fifty-four lichen taxa growing as part of the terrestrial soil crust community. Thirty-six of these taxa have been identified to species, while the identifications of the remainder are conditional at present. Of these, four taxa have tentative species identifications and fourteen have been identified to the genus only. Twenty-six lichens are common and widespread to locally common across the Monument, and the remaining taxa are uncommon to rare.

In addition to the terrestrial lichens, at least twenty-six taxa of saxicolous lichens were collected growing on rock outcrops, rocks, or stones. Most collections of saxicolous lichens have been identified to genus only; five taxa are still of unknown identity. Not enough information is available to assess the distributions of saxicolous lichens.

Eleven lichen taxa are epiphytic on the bark of shrubs and trees. Most have been identified to genus, with species identification pending. Most of the epiphytic lichens appear to be relatively widespread, at least where sagebrush is present. Four lichen species are found on two substrata. *Lecanora muralis* and an unknown, *Xanthoria*-like lichen are both primarily saxicolous, but are also found on soil. *Physconia enteroxantha* is found commonly on both bark and soil, and *Candelaria concolor*, primarily epiphytic, is occasionally found on soil.

3.9.3 Upland Community Types

3.9.3.1 Big Sagebrush/Bluebunch Wheatgrass

This potential community type is characterized by big sagebrush, bluebunch wheatgrass, Sandberg's bluegrass, diverse forbs, and where relatively undisturbed, a robust microbiotic crust. As the climatic climax community, it is widespread in many (loamy) soil types, although frequently with a high cheatgrass cover. Where fire has recently burned, sagebrush is generally absent. Under more mesic conditions, Cusick's bluegrass can be a common component.

The ALE supports the largest expanse of this type in the Monument. It covers nearly 30,000 acres in a broad band between 900 feet and approximately 2,500 feet in elevation, much of it in excellent ecological condition. In fact, the element occurrence of this type in the ALE is the largest known example in the world.

The Wahluke Slope supports only small occurrences, mostly at high elevation on the Saddle Mountains or in other, mostly small, areas with loamy (versus sandy) soil. Over much of the Wahluke Slope, precipitation is too low and soils are too sandy for bluebunch wheatgrass. In some large areas with apparently appropriate soils and climate, this community type may have been replaced by the big sagebrush/cheatgrass type or big sagebrush/Sandberg's bluegrass type as a result of over-grazing and fire. Although it covers nearly 10,000 acres on Central Hanford, this community type is limited in distribution to relatively deep soil areas on the north slope of Umtanum Ridge in the McGee Ranch/Riverlands Unit; to small areas mostly near basalt in the northern portion of Central Hanford; and to an area along the Columbia River on the eastern portion of the Monument. The latter occurrence represents an unusual sandy phase of the community type that is ecotonal with the big sagebrush/needle-and-thread potential plant community type. With the exception of the McGee Ranch/Riverlands Unit, which has an element occurrence on the north slope of Umtanum Ridge, at most locations the condition of the

community ranges from poor to marginal, with marginally good conditions on the north-facing slopes and shallower soils of basalt areas.

3.9.3.2 Big Sagebrush/Sandberg's Bluegrass

It seems likely that in Washington, this plant community type is confined to locations too dry for bluebunch wheatgrass to become established and on soil that is finer textured than is typical for needle-and-thread types. It may also occur as a so-called *zootic* (literally, *from animals*) climax where grazing has eliminated larger, later-growing bunchgrasses. In general, in the Hanford Site a high cover of big sagebrush and low forb diversity is characteristic of this type. Spiny hopsage may occur, especially at drier sites, with cover ranging from widely scattered individuals to a few locations at which it was co-dominant with big sagebrush.

On the ALE, this type covers more than 9,000 acres, nearly all of it in two large patches in the northwest corner between Dry Creek and the Benson Ranch. Elevation ranges from about 700 feet to 1,000 feet. Condition ranges from poor to good, with some areas supporting relatively little cheatgrass and a continuous microbiotic crust. This plant community type also occurs in large areas of the Wahluke Slope, totaling more than 9,000 acres scattered around the site in four large patches. As with the ALE, condition varies with site history.

Within Central Hanford, this type occurs mostly south of Gable Mountain and areas farther to the west, where silt, rather than sand as at most lower elevations, dominates Pleistocene flood sediments (Gaylord and Stetler 1994). In these areas, recorded precipitation is the lowest of the Hanford Site (Hoitink and Burk 1995). Two areas qualify as element occurrences—a strip along a north-facing slope on the eastern end of Umtanum Ridge and an area south of Gable Mountain.

Although vegetation resembling this type exists over a large area, especially in Central Hanford, it is difficult to distinguish from degraded occurrences of other types in which the larger bunchgrass taxa have been eliminated by historic use and/or fire. Therefore, the possibility cannot be discounted that the big sagebrush/Sandberg's bluegrass potential plant community type is actually more widespread in Central Hanford than indicated here.

3.9.3.3 Big Sagebrush/Needle-and-Thread

This community is present in a range of soils, from those with a significant component of sand (sandy loam) to stabilized dunes. Big sagebrush is the dominant shrub, although bitterbrush commonly occurs at varying levels. Thickspike wheatgrass may occur in the understory with the needle-and-thread. Where it is intermixed with bluebunch wheatgrass, needle-and-thread grass is thought to increase with disturbance. In the Hanford Site, it is least abundant in the ALE

where loamy soils generally predominate. It is limited there to small occurrences near the lower elevation boundary of the big sagebrush/bluebunch wheatgrass community.

Big sagebrush/needle-and-thread grass communities occur in several areas on the Wahluke Slope. The most prominent of these areas are: a large area along the eastern boundary, south of State Route 24, where much of the shrub cover has been eliminated by a recent fire; along the crest of the Saddle Mountains where it intergrades with big sagebrush/bluebunch wheatgrass; and above the White Bluffs in the southeastern corner of the site. Much of the now-degraded lower elevations on the Wahluke Slope probably supported this type before being converted to cheatgrass by grazing and fire. Although much of this community type has been degraded by grazing and fire, some areas retain significant native character. These include some of the area south of State Route 24 and the southeastern portion of the Hanford Site; that large examples of these communities exist at all is due to the protection afforded by the Hanford Site. Nearby sites that once supported this community have been converted to irrigated agriculture as part of the Columbia Basin Project.

This plant community type also occurs on sandy-textured soils throughout Central Hanford and in the Riverlands. It often intergrades with other types, including the bitterbrush/Indian ricegrass dune complex in the eastern portion and a sandy phase of the big sagebrush/bluebunch wheatgrass type in the southeastern section. Portions of the area mapped as this type have had more than one fire during recent decades. In these areas, the cover of the indicator shrub and grass species usually are low. The cover and diversity of mosses and lichens in the microbiotic crust are variable, but generally low. Areas in better ecological condition (i.e., with a high cover of needle-and-thread grass and microbiotic crust) occur mostly in the eastern portion of Central Hanford, often on stabilized sand. Compared to other plant communities and soil types in Central Hanford, plant communities on sandy soils seem the most resilient to disturbance.

3.9.3.4 Bitterbrush/Indian Ricegrass Dune Complex

This community type occurs on active dunes and other extremely sandy soils. As opposed to relatively cool and moist western and northern portions of the ecoregion where it grows in loamy soils, bitterbrush is only found in nearly pure sand within the hotter and drier central Columbia Basin. Plant composition is highly variable, changing with subtle shifts in substrate and presumably time as an active dune becomes stable (or vice versa), but sagebrush is generally absent. As such, the boundaries of this type are fluid and difficult to map. Succession and stabilization of a dune site apparently leads to the development of other potential plant community types (probably most often the big sagebrush/needle-and-thread type). As a result, the dune complex encompasses several related successional cover types, each composed of taxa adapted to different degrees of sand accumulation, loss and stability.

On the Wahluke Slope, the antelope bitterbrush/Indian ricegrass dune complex covers large areas directly above the White Bluffs. Along with the occurrences in Central Hanford, it makes up the most extensive, highest quality occurrence of this type known in the state of Washington.

This community type occurs in only two small patches in the ALE. Most of this area is far from pristine, with native grasses often replaced by cheatgrass and tumbleweeds. However, because it has been replaced by agriculture nearly everywhere else it once occurred, even small occurrences are ecologically important.

3.9.3.5 Big Sagebrush/Cheatgrass

This designation represents areas with extensive cheatgrass and other exotic species cover with or without big sagebrush in which the original/native potential plant community type could not be determined, or where it has likely been permanently replaced. This is the situation over much of Central Hanford, and indeed in highly degraded or sandy soil areas throughout Hanford, where identification of potential plant community types is difficult. Particular difficulties are faced in identifying plant community types where historic disturbances is the most intense (especially on historically farmed locations). Much of the documented, unexplained big sagebrush die-off is located in this area. Vegetation within this designation has highly variable shrub cover, a high cover of cheatgrass, frequently a significant cover of Sandberg's bluegrass, and usually a low cover of microbiotic crust. This designation represents vegetation in a degraded condition; however, there is considerable variability in the amount and rate of successional changes of areas mapped as this designation. Some areas appear to be recovering towards native vegetation, whereas other areas appear to be permanently modified.

3.9.3.6 Sand Dropseed/Sandberg's Bluegrass

This plant community type is characterized by a lack of shrubs and dominance by the two grass species for which it is named. Areas mapped as this type are located in the northern and northeastern portions of Central Hanford, within the lowest elevation upland plant communities near the Columbia River, and in similar locations scattered throughout the Wahluke Slope. Sand dropseed is found along roadways and other highly disturbed areas scattered throughout the northern portion of Central Hanford. It is difficult to determine whether the species is present because of disturbance, or if its presence represents a potential plant community type. It is only mapped as a possible potential plant community type adjacent to the river, usually within the river's probable maximum flood area (Cushing 1995). The cover of Sandberg's bluegrass is often sparse and that of cheatgrass high. Overall plant diversity within the type is low, and many components are weedy. The climax status of the type is uncertain. When sand dropseed occurs without Sandberg's bluegrass, it probably represents a climax riparian community type (Johnson

and Simon 1987) that occurred historically in a zone disturbed by floods frequent enough to exclude other bunchgrasses and shrubs.[57]

3.9.3.7 Spiny Hopsage/Sandberg's Bluegrass

The spiny hopsage/Sandberg's bluegrass community occurs on dry sites with fine-textured soils and likely represents an unusual variant of the big sagebrush/Sandberg's bluegrass community. (One possible explanation for the absence of sagebrush is intermittent pooling of water [Downs et al. 1993].) Sandberg's bluegrass is the dominant grass, although cheatgrass is a major or dominant component in most areas of the Hanford Site. Forb diversity and crust cover are generally low. This type occurs as pure stands of spiny hopsage on the Wahluke Slope and Central Hanford and mixed with big sagebrush in loamy soils throughout drier areas of the Hanford Site. On the Wahluke Slope, it occurs mostly in the central portion of the White Bluffs, but it can also be found in scattered locations in the southwest portion.

3.9.3.8 Winterfat/Sandberg's Bluegrass

This unusual community has winterfat as the dominant shrub and Sandberg's bluegrass as the major grass. It occurs on Warden or Kennewick silt loam soils (notably calcareous) around 800 feet in elevation in the ALE and Wahluke Slope. Overall species diversity is low in this community, although Piper's daisy, a rare plant, frequently occurs. The largest occurrence on the Monument is on the lower slopes of Rattlesnake Mountain where it occurs in a five-by-one-mile area on small ridges separating the numerous small draws that come off the mountain; the intervening draws typically support big sagebrush/bluebunch wheatgrass or needle-and-thread communities. A second, smaller occurrence is on the Wahluke Slope near the northwest site boundary north of State Route 24.

3.9.3.9 Stiff Sagebrush/Sandberg's Bluegrass

Stiff sagebrush grows on thin soils over fractured basalt. This plant community type occurs on the crest of the Saddle Mountains, in a tiny occurrence on ridge crests in the Cold Creek Valley, and intermittently on shallow soils over basalt on Umtanum Ridge. The cover of soil mosses and lichens is consistently high. The ecological condition of the type is generally marginal.

[57] It should be noted that there have been no floods since at least 1948 that approach the probable 100-year flood event.

3.9.3.10 Desert Buckwheat (Various)/Sandberg's Bluegrass

These communities are characterized by various desert buckwheats (thyme, Douglas', rock), Sandberg's bluegrass, a microbiotic crust, and diverse forbs. They typically occur on ridge tops above 1,500 feet in elevation; the only occurrences in the Hanford Site are on ridge tops throughout the ALE. These communities are generally in good ecological condition and are important habitat for butterflies.

3.9.3.11 Three-tip Sagebrush Communities

At higher elevations in the ALE (primarily above 2,000 feet), three-tip sagebrush begins to occur with, or replaces, big sagebrush as the dominant shrub. Unlike big sagebrush, three-tip sagebrush resprouts following fire; it is therefore frequently the only shrub present in what would otherwise be mixed bunchgrass communities. Bluebunch wheatgrass is typically the dominant grass, but when Idaho fescue is present (typically on steep north slopes), the community is named for it (i.e., three-tip sagebrush/Idaho fescue). Cusick's bluegrass is also often present. These community types are characterized by high vegetation cover and diverse forbs. Most sites in the Monument are in good ecological condition.

3.9.3.12 Low Elevation Alkaline Vernal Pools

Shallow vernal pools occur on Gable Mountain, Gable Butte, and the eastern end of Umtanum Ridge on basalt shelves and dips that form internal drainages. Each pool is dominated by herbaceous vegetation that differs according to the depth, size and condition of the pool. Surrounding potential plant community types include big sagebrush/Sandberg's bluegrass and big sagebrush/bluebunch wheatgrass. Historic livestock use has affected the pools, and they are mostly moderately to severely degraded. Several rare plant species are present, and on this basis the pools, especially those on Gable Butte, are still a high priority for conservation.

3.9.4 Riparian and Hanford Reach Plant Communities

Only the summaries of the major plant communities of the wetlands, springs and riparian areas in the Hanford Site and within the Hanford Reach are described here. Descriptions of all the identified communities are available in Wilderman (1994) and Salstrom and Easterly (1995).

3.9.4.1 Willow Riparian Complex

This riparian community is characterized by diverse shrubs and trees that include a substantial component of, or dominance by, willows. Because of its association with water and its value as wildlife habitat, this type is a very important component of the Monument. It occurs on the ALE in the vicinity of Rattlesnake Springs, Snively Canyon, and Benson Springs, although composition varies among the three sites. Small groves of narrowleaf willow occur sporadically above the high waterline throughout the Hanford Reach. Within these groves, the willows usually form thickets averaging five feet in height, and the understory is commonly dominated by reed canarygrass.

Unfortunately, the spring complexes on the ALE were severely damaged by the 24 Command Fire and have yet to fully recover. It will likely take several years to return to the condition described above.

3.9.4.2 Non-Persistent Riverine Emergent Wetland

Backwater areas and sloughs often form in the lee of cobble bars where silt has been deposited; this silt provides for wetland communities. The largest wetland systems are associated with the most developed cobble bars, such as on the lee side of Locke Island. Others are scattered throughout the north shore. This habitat system is thought to be rare elsewhere along the Columbia River, but may have been common before the extensive construction of hydroelectric dams (Downs et al. 1994). These systems are rich in species diversity, both within and between sites. Dominant species include common spikerush, needle spikerush, alkali bulrush, western lilaeopsis, broadleaf cattail, and various rushes. Three species that occur abundantly and consistently within these wetlands are currently considered sensitive in Washington—slender flatsedge, false pimpernel, and Owyhee mudwort (WDNR 1994). On the Monument, this plant community type is often relatively pristine.

3.9.4.3 Unconsolidated Shore, Cobble

A collar of mostly bare cobble occupies most of the lowest portion of the shoreline. This zone is heavily disturbed due to the almost daily inundation during the growing season from waterflow manipulation upriver at Priest Rapids Dam. A number of forbs, including the rare species persistentsepal yellowcress, occur in this zone. On flat profiles, this zone intergrades into low shrub communities. Farther up the riparian profile, but below daily high water, the rhizomatous shrubs Indian hemp and western goldentop commonly form a perimeter thicket. Indian hemp is confined to this zone but occurs irregularly. Western goldentop is omnipresent, but also occurs in adjacent zones. Occasionally, particularly on slopes of more than 15%, this zone is absent or replaced by a monoculture of reed canarygrass.

3.9.4.4 Irrigation Run-off Created Wetlands

This artificial community type includes lakeshores, riparian areas, and wetlands on the Wahluke Slope that have been converted from shrub-steppe due to accumulated run-off from irrigated agriculture. The largest examples are just south and five miles south of State Route 24 in the eastern end of the Monument and around Saddle Mountain Lake on the western end. Small examples occur periodically along the White Bluffs due to water seepage through the Bluffs. Communities in these wetlands are typically dominated by non-native species such as tamarisk and Russian olive, but also support native willows and cattails and black cottonwood. Although artificial, these areas can provide valuable wildlife habitat, especially for amphibians, birds and bats in an otherwise arid landscape.

3.9.4.5 Island Upland

Three communities are recognized on islands within the Hanford Reach: the northern wormwood/sand dropseed community occurs where upland areas are seasonally flooded but above frequent high water; the flatspine burr ragweed/Indian ricegrass community occurs on a small dune system on an unnamed island at the head of Wahluke Bend; and a cheatgrass community (see discussion above on unknown potential communities) covers portions of Locke Island. Patches of thickspike wheatgrass and Great Basin wildrye occur within this zone.

3.9.5 Endangered, Threatened, Rare, or Sensitive Plants

Rare plant species refers to any vascular plant species listed by the WNHP as endangered, threatened, or sensitive in the state of Washington. None of the species potentially present on the Hanford Site that are on the rare plant species list are presently federally listed. Several, however, are identified as federal candidates for listing or species of concern (see Table 3.3).[58]

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[58] **This footnote applies to both plants and animals (see Section 3.11).** Federal candidate species are those that may warrant listing as endangered or threatened. The FWS defines a candidate species as a species for which there is sufficient information on file relative to status and threats to support issuance of a proposed listing. The National Oceanic and Atmospheric Administration-Fisheries (formerly the National Marine Fisheries Service) defines a candidate species as a species for which concerns remain regarding their status, but for which more information is needed before it can be proposed for listing. On February 28, 1996, the FWS redefined the federal candidate species category (61 FR 7595). As a result, several former categories of candidate species were eliminated; the previous Candidate 1 category is now the only remaining category. Many species previously included in the now eliminated categories are presently tracked as species of concern by state and local offices of the FWS. Thus, the conservation standing of these species is still of concern to the FWS; however, their identification as such is no longer being published in the *Federal Register*, and they do not receive any formal recognition or protection under the Endangered Species Act. Lists of species of concern are generated and maintained through partnerships between

Fifteen plant species occurring on the Monument and previously without a conservation status were assigned a status that ranges from Review Group 1 to endangered. Four additional species were upgraded (i.e., assigned to a category of increased conservation concern), and four others were downgraded. Because these definitions apply to vascular plant taxa, they can be applied at the taxonomic rank of either subspecies or variety, as well as to species. In the remainder of this section and the EIS, the term *taxon* (or the plural *taxa*) is used when not otherwise referring specifically to a species. The status categories are listed and described below.

- ***Endangered.*** The taxon is in danger of becoming extinct or extirpated (i.e., locally extinct) in Washington within the near future if factors contributing to its decline continue.

- ***Threatened.*** The taxon is likely to become endangered in Washington within the near future if factors contributing to its population decline or habitat degradation or loss continue.

- ***Sensitive.*** The taxon is vulnerable or declining in numbers and could become endangered or threatened in Washington without active management or removal of threats.

Eleven species of Hanford Site plants are listed in Washington State as threatened or endangered (WNHP 2002), nine within the Monument and two in Central Hanford. Many of the listed threatened plants are limited in range and dependent on protection of specific habitat types and associations. Several are perennial plants that exist is discrete locations, while others are annual plants that require specific climatic conditions, disturbance patterns, and habitat features in order for populations to be maintained. Umtanum desert buckwheat, which occurs in localized small populations on Umtanum Ridge, and the White Bluffs bladderpod, which occurs on the White Bluffs, are found only in the Hanford Site and nowhere else in the world (Soll et al. 1999). These two species are candidates for listing as endangered or threatened under the federal Endangered Species Act (ESA). Persistentsepal yellowcress occurs in the wetted zone of the water's edge along the Hanford Reach and in Washington is limited to this portion of the Columbia River and one other site below Bonneville Dam. Several other of the state-listed threatened and endangered plant species (aristulate lipocarpha, scarlet ammannia, and lowland toothcup) are restricted to wetlands in the riparian zone of the Columbia River. Three of the state-listed plant species (Geyer's milkvetch, white eatonella, and desert dodder) have been found at upland sites on the Wahluke Slope. Loeflingia and rosy calyptridium, both state threatened species, are small annuals that have been found in relatively undisturbed sagebrush areas around Gable Mountain on Central Hanford.

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the FWS and appropriate federal and state agencies and private organizations. Plant species identified herein as federal species of concern are based on a list provided by the Spokane Office of the FWS (1998).

Two additional species of listed plants are considered as possible inhabitants of the Hanford Site. Northern wormwood is a federal candidate for listing and is a Washington State endangered species. It is known to occur near Beverly; however, surveys by TNC (Soll et al. 1999) did not find any occurrences along the northern shoreline of the Columbia River. TNC believes the only remaining portions of the Hanford Site that could support northern wormwood are islands in the Hanford Reach. Similarly, Wanapum crazyweed is only found near the western end of the Saddle Mountains and could also be found in the Hanford Site. This plant is a federal species of concern and is listed as endangered by the state of Washington.

During three years of fieldwork, a total of 112 populations/occurrences of twenty-eight rare plant taxa were located in the Hanford Site. Twenty-three of these taxa were not previously known to exist in the Hanford Site. In addition, numerous populations of seventeen taxa were not previously known in Washington State or were otherwise of botanical interest and potentially of conservation and management concern. The highest rare plant densities occur on the eastern end of Umtanum Ridge, the McGee Ranch/Riverlands Unit, basalt-derived sands near Gable Mountain, the White Bluffs, Rattlesnake Mountain, Yakima Ridge, and within riparian communities along the Hanford Reach.

During 1997, eight special habitat areas were delineated. These areas encompass habitat for populations of certain rare plant species, generally annuals, whose locations are patchy, whose habitat is dynamic (e.g., dune fields), and whose occurrence may vary over time in response to changes in weather patterns. Special habitat areas are mostly located in proximity to the basalt ridges of Central Hanford. When rare plant occurrences located before 1994 are included, a total of 127 populations/occurrences of thirty rare plant taxa are now documented on the Hanford Site. This is a tremendous amount of rare plants, both in terms of species richness and abundance, to occur in an area the size of the Hanford Site. One of the highlights of the rare plant surveys in the Hanford Site was the discovery of two plant species and one variety of a species that are new to science—Umtanum desert buckwheat, White Bluffs bladderpod, and basalt milk-vetch, respectively.

Among the most interesting special habitat areas are three previously undocumented clusters of approximately twenty vernal pools. Each cluster contains one or more rare plant species. Vernal pools in Washington are little known or studied, and their occurrence in Hanford is significant. The Hanford Site pools are located on the eastern end of Umtanum Ridge, near Gable Butte, and on Gable Mountain.

Legal protections for species of concern differ between plant and animals. Although legal protections for federally listed or proposed (for listing) plant species, insofar as they address plants found on federal property, are similar to that for animals, protection is limited on non-federal lands (i.e., state and private) to situations in which either federal funding or the requirement for a federal permit is involved. Legal protection for state-listed species in Washington is even more limited. There are no Washington State laws that specifically

recognize endangered or threatened plants or afford them any protection on any lands; however, the WNHP does identify and track the status of species deserving of such status (WDNR 1994).

A complete list of all taxa observed in the various management areas in the Hanford Site during the 1994, 1995 and 1997 field surveys is provided in Caplow and Beck (1997). This list of 508 plant taxa includes eighty-five plant taxa unknown in the Hanford Site before 1994 surveys and can be considered an addendum to Sackschewsky and Downs (2001).

3.9.5.1 Plant Species New to Science

In addition to the overall diversity of rare plant species and the abundance of rare plant occurrences/populations in the Hanford Site, one of the highlights of the rare plant surveys was the discovery of species new to science.

3.9.5.1.1 Rattlesnake Mountain Milkvetch (Basalt Milkvetch)

Astragalus conjunctus var. *rickardii*, a relatively common milkvetch on the north-facing slopes and summit of Rattlesnake Mountain, has been determined to be a new variety. For many years prior to this determination, it was mistakenly referred to as the variety *reventiformis* (Yakima milkvetch). On the Monument, the milkvetch is scattered in bunchgrass areas along the main ridges of Rattlesnake Mountain where the population includes several tens of thousands of plants. However, the population remains incompletely mapped. The two known locations of the plant are both in Benton County—the large population on Rattlesnake Mountain and a small population in the Chandler Butte portion of the Horse Heaven Hills. The Monument's population is entirely included within the boundaries of the ALE where it benefits from very limited access and low disturbance levels. Maintenance of public ownership and the current management regime are the most likely methods to ensure the long-term survival and viability of this plant.

3.9.5.1.2 Umtanum Desert Buckwheat

Previous to the 1995 biodiversity surveys, this species had never been described. Currently it is listed as endangered by the state of Washington (WNHP 1997) and identified as a candidate for listing by the FWS (1998). Despite some mortality from a fire in 1996, there is an estimated population of 5,200 plants. Some individual plants are estimated to be well over 100 years old (Reveal 1995). Several state-listed species—Hoover's desert-parsley, Columbia milk-vetch, and Piper's daisy—occur within the vicinity of the newly discovered population, as does a population of sand gilia, previously not known in Washington.

Umtanum desert buckwheat appears to be restricted to a discontinuous mile-long strip generally less than 100-feet wide on the McGee Ranch. This is within an area receiving little use and is officially not accessible to the public. However, fences in the area are regularly cut and trespassing occurs. A portion of the site has visible petrified wood, and there are signs of collecting within the buckwheat population. Long-term demographic monitoring was initiated on this species in 1997.

3.9.5.1.3 White Bluffs Bladderpod

This species was first described on the Hanford Site in 1994 biodiversity surveys. It is listed as threatened by the state of Washington (WNHP 1997) and identified as a candidate for listing by the FWS (1998). The total count of adult plants in 1997 was estimated to be 50,000 plants spread across an eight-mile-long occurrence. Several other rare plant populations exist in the immediate area, including dwarf evening primrose, Piper's daisy, Snake River cryptantha, and desert dodder.

The White Bluffs are a unique exposure of the Ringold Formation; the bluffs are made of soft Pliocene lacustrine deposits of clay, sand and silt (Newcombe 1958). The top is capped in many places by a harder calcium carbonate (caliche) layer (Lindsey 1994). White Bluffs bladderpod appears to be restricted to this caliche layer. Most of the population is outside the Hanford Reach corridor (technically 0.25 mile on either side of the river).

The primary threats to the bladderpod population are erosion, conversion of habitat, weed invasions, or slumping of the bluffs due to illegal off-road vehicle use or irrigation. Infestations of yellow starthistle, a noxious weed, are located within the middle portion of the bladderpod population. The protection of this population, and thus the species, requires that these issues be addressed in any management action. Long-term demographic monitoring was initiated on this species in 1997.

3.9.5.2 Plant Species of Interest

The Hanford Site and the Monument support numerous plants of special interest to the FWS in addition to those described above. A summary of those is provided below. See Appendix F for additional detail, and see the cited references for complete details on the plants.

3.9.5.2.1 Awned Halfchaff Sedge

Awned half chaff sedge is a state threatened wetland species that ranges from California to Washington and the southeastern United States (Hickman 1993). It was not previously known

on the Hanford Site prior to 1994; in 1994, it was found in thirteen locations along the Hanford Reach, all below high water. These locations are considered one population.

3.9.5.2.2 Canadian St. John's Wort

Canadian St. John's wort ranges from British Columbia to Quebec, southward through Colorado, Illinois, Iowa, New Jersey, and Pennsylvania. It is generally rare in western North America and has a scattered distribution in Washington; Canadian St. John's wort is a state sensitive species. Three new populations of Canadian St. John's wort were located within the Hanford Reach in 1994, two on Central Hanford, and one on the Wahluke Unit. The Hanford Site populations represent a southern range extension in the Pacific Coast region. It is also a departure in the type of habitat the taxon typically inhabits in western North America—a wetland adjacent a large river in arid shrub-steppe, as opposed to a pond or lakeside in montane or forested regions.

3.9.5.2.3 Chaffweed

Chaffweed is a diminutive, annual herb in the primrose family. It is unusual in the shrub-steppe region, although it ranges from California to British Columbia and is widespread in eastern North America, South America, and Europe. It is listed as rare in British Columbia and Alberta. On the Hanford Site, chaffweed is located on the Hanford Reach in two riverine emergent wetlands in conjunction with several other rare plant taxa. Its habitat is shores, seepage areas, vernal pools, and other moist areas from the coast to inland valleys.

3.9.5.2.4 Columbia Milkvetch

Columbia milkvetch is considered sensitive in Washington and is a federal species of concern (WNHP 1997). It is a local endemic and is found in Benton, Kittitas and Yakima Counties in south-central Washington. It was once thought to be extinct but has since been found to be relatively common on the Yakima Training Center and other locations within its limited range (Sauer et al. 1979). Nine occurrences are known on the Hanford Site. The Yakima and Umtanum Ridge populations represent small range extensions to the south and east of its previously known range.

Most of the Hanford populations grow in big sagebrush/bluebunch wheatgrass and big sagebrush/Sandberg's bluegrass plant community types, mostly in well-drained sandy and gravelly loams, lithosols and cobbly sand. The sites are frequently in early seral stages following disturbance. Columbia milkvetch has been found on the sides and medians of lightly used gravel roads, and its density and frequency has been found to increase after fire.

3.9.5.2.5 Coyote Tobacco

Coyote tobacco is a native annual forb that is easily recognized by its glandular foliage and white, tubular flowers. Its range is typically east of the Cascades from southern British Columbia and northern Idaho and Montana to Baja California, New Mexico, and northwest Mexico. In Washington, coyote tobacco has a scattered distribution, with present occurrences known in Douglas, Grant, Kittitas, Klickitat and Yakima Counties. Historic sites include Chelan and Franklin Counties.

Habitat for this species is noted as dry sandy bottomlands, dry rocky washes, and other dry open places. Coyote tobacco occurs in areas that are prone to periodic disturbances, caused by either erosion or human activities.

This state sensitive species was recorded on the ALE in 1999 in an area that had burned in 1998. The germination of this plant seems to be stimulated by smoke residues. Until this recent collection, this species had not been recorded near Hanford for nearly 100 years.

Due to the amount of disturbance to its habitat, both natural and human-caused, coyote tobacco is associated with several aggressive exotic species that have invaded the habitat and presumably compete for resources. This, combined with the relatively large number of historical collections of the taxon in Washington and the few currently known sites, suggests that the species may be in decline in the state.

3.9.5.2.6 Desert Cryptantha (Miner's Candle)

Desert cryptantha is a regional endemic that is most common on the Snake River Plains of Idaho, extending into a few counties in adjacent Nevada, Oregon, and Utah, and disjunct to Yakima County, Washington. In Washington, it is a sensitive species. There have been no new collections during the last fifty years in Washington. Desert cryptantha was found on Yakima Ridge within the ALE on a sparsely vegetated, south-facing slope with big sagebrush and winterfat. The population was not vigorous, even during an unusually wet year. There may be no germination in a dry year. Due to the superficial similarities between desert cryptantha and other annual cryptantha species, other populations on Yakima Ridge or in the Hanford Site may have been overlooked.

3.9.5.2.7 Desert Dodder

Desert dodder ranges from California to Arizona, Baja (California), Nevada and Utah (Hickman ed. 1993). The Idaho and Washington populations are disjunct from the range of the species. In 1984, the single known population in Washington was collected on private land in the Cold

Creek Valley in Benton County just west of the western boundary of the Monument. It is likely that this population has since been destroyed by conversion into a wheat field; however, new populations have been identified on the Monument; three populations were located adjacent to the White Bluffs in the Wahluke Unit.

The plant is a parasite on big sagebrush and on Hanford is found within the big sagebrush/ Sandberg's bluegrass community.

Desert dodder is listed as threatened in Washington. Potential threats include vehicular traffic, road maintenance, wildfire, grazing and agricultural conversion of habitat. The populations in the Monument are located within fifty feet of a small dirt road that is accessible to the public.

3.9.5.2.8 Desert Evening Primrose

Desert evening primrose is found throughout much of the western United States; Washington is considered peripheral to its main range (WNHP 1997). There are a total of three recently documented occurrences and one occurrence that was located before 1985 known from outside the Hanford Site (WNHP 1995). Field surveys conducted in 1995 located five new populations, two each in Central Hanford and the ALE and one in the Saddle Mountain Unit. Two populations are located along the Columbia River, above the high water level on nearly flat river terraces. The desert evening primrose population at the southern base of Yakima Ridge in the ALE is the largest population of plants found in the Hanford Site. While the surrounding area is quite weedy, the immediate area is relatively high-quality.

Desert evening primrose favors dry, open habitats, occurring as individuals or colonies on clay soils, rocky slopes composed of shales, volcanics, sandstones, bluffs and exposed rocky ridges. The taxon also colonizes roadcuts in grasslands and sagebrush.

Desert evening primrose is considered sensitive in Washington. The population on the ALE is probably stable because the area is off limits to the public and grazing. Populations adjacent to the river are vulnerable to changes in hydrology and disturbances due to river-related recreational activity. These populations and those on the gravelly White Bluffs over the river are also vulnerable to competition with aggressive, weedy plants accentuated by physical disturbance.

3.9.5.2.9 Dwarf Evening Primrose

Dwarf evening primrose is considered sensitive in Washington, where is it has a scattered distribution and is a regional endemic (WNHP 1997). The taxon was believed to range from central Washington to eastern Oregon and adjacent southern Idaho (Hitchcock 1973). Fourteen

occurrences have been located on the Hanford Site, including locations in the White Bluffs in the Wahluke and Saddle Mountain Units and on and around Gable Mountain in Central Hanford. The newly located populations on the White Bluffs make it one of the largest known concentrations of dwarf evening primrose plants in its range.

Dwarf evening primrose grows in gravelly soils in the big sagebrush/Sandberg's bluegrass association in conjunction with other rare plant species, including Snake River cryptantha, white eatonella, White Bluffs bladderpod, desert evening primrose, and bristly pectocarya.

Illegal use of off-road vehicles in the publicly accessible Wahluke Unit threatens two previously known occurrences. Off-road vehicle use affects these occurrences not only by physically damaging plants, but also more significantly by rutting and eroding slopes. Another threat to these and all populations on the bluffs are hydrologic changes (i.e., increase in irrigation) up slope of the bluffs, which could result in seepage and slumping of the exposed face of the bluffs.

3.9.5.2.10 Fuzzytongue Penstemon

Fuzzytongue penstemon is listed as Sensitive in Washington, where it is locally endemic to the Columbia Basin. It is found in Chelan, Douglas, Klickitat, and Yakima Counties. Its general habitat is open, often rocky places in the foothills and lowlands (Hitchcock et al. 1973). On the Hanford Site, two populations grow on the White Bluffs near the southern boundary of the Wahluke Unit. One of the populations has approximately 400 plants on the steep, west-facing slopes of a series of six canyons, while the other has more than 200 plants in two sub-populations. Associated plant communities are relatively high-quality. Fuzzytongue penstemon grows in conjunction with a number of rare plant species, including White Bluffs bladderpod, dwarf evening primrose, and Snake River cryptantha. Populations are in an area of the Wahluke Unit that is open to the public; they could eventually be affected by irrigation-related slumping of the White Bluffs if there is substantially degradation from irrigation. Illegal off-road vehicle use has also been documented in the area.

3.9.5.2.11 Geyer's Milkvetch

Geyer's milkvetch (variety *geyeri*) is considered threatened in Washington, where it is disjunct from its main range (WNHP 1997). The general habitat of Geyer's milkvetch includes depressions in mobile or stabilized dunes, sandy flats, valley floors, draws in gullied hills, and margins of alkaline sandy playas (Barneby 1989). It is generally a Great Basin and Snake River Plains species, known from southeast Oregon to California and Nevada and eastward through southern Idaho to Utah and Wyoming. Prior to a 1994 survey, two occurrences of the plant were known from Grant County, both verified since 1984 (WNHP 1997). During the 1994 field season, four populations of Geyer's milkvetch were located in the Saddle Mountain Unit.

3.9.5.2.12 Gray Cryptantha

Gray cryptantha is considered sensitive in Washington, where it is a regional endemic. It is found in the Columbia and lower Yakima Rivers in the western Columbia Basin and from Wenatchee, Washington, to The Dalles, Oregon. Prior to a 1994 survey, there were only thirty-six known occurrences in Washington, twenty-four of which had not been visited since 1984, and four of which were in the Hanford Site. The 1994 survey found ten new populations in the Hanford Site (eight in the Wahluke Unit, one in Central Hanford, and one in the Saddle Mountain Unit).

Gray cryptantha grows on swales and slopes of somewhat- to moderately well- vegetated sand dunes and other sandy habitats in the White Bluffs and the Hanford Dune Field. It is usually found with the bitterbrush/Indian rice-grass dune complex plant association. Associated plant species include antelope bitterbrush, Indian ricegrass, and needle-and-thread grass. Most populations have a low to moderate cover of weedy plants. Populations of gray cryptantha are located on Central Hanford and the Wahluke and Saddle Mountain Units. The size of the populations varies dramatically, ranging from 0.1 acre to more than 600 acres.

Off-road vehicle use, irrigation-related groundwater changes, stabilization of sand dunes by weedy plants or changes in sand deposition, and agricultural conversion of habitat all pose threats throughout its range. Six of the eight new populations found in the Hanford Site are accessible to the public; illegal off-road vehicle use was observed in the vicinity of half of the populations. Several of the populations are located in areas where irrigation-related groundwater movement could or is causing slumping of the White Bluffs and the sand dunes immediately up-slope of the bluffs. A significant number of sand dunes and sandy areas on private lands in the area have been converted to orchards and agriculture, contributing to the rarity of this taxon.

3.9.5.2.13 Hoover's Desert-Parsley

Hoover's desert-parsley is a local endemic found only in Benton, Grant, Kittitas and Yakima Counties in south-central Washington. Prior to 1995, there were twenty-four known occurrences, eight of which had not been visited since 1985. One of these occurrences is on the steep, north-facing basalt talus slopes of Umtanum Ridge in the Hanford Site (WNHP 1995). During the 1995 survey, nine new populations of Hoover's desert-parsley were found; they have been combined into one occurrence. Populations on the Monument and in Central Hanford are near populations of Columbia milkvetch (sensitive) and Umtanum desert buckwheat (endangered). Hoover's desert-parsley is considered sensitive in Washington and is a federal species of concern (WNHP 1997).

In the Hanford Site, Hoover's desert-parsley is found on a substrate of loose active basalt talus, averaging three to eight inches in diameter. The vegetation community is generally big sagebrush/bluebunch wheatgrass.

3.9.5.2.14 Loeflingia

Loeflingia—a widespread western and southwestern species with a number of recognized varieties—had a known range from northern Baja California and the southern coast of California, through the San Joaquin Valley, and north to Santa Cruz County, California (Hickman ed. 1993). The 1994 survey changed that. The Hanford Site populations are disjunct from the range of the species by at least 300 miles and from the range of the variety by approximately 800 miles. In Washington, loeflingia is threatened.

On the Hanford Site, five small populations were found on low basalt sand dunes to the north and south of Gable Mountain, generally in small swales and depressions in sparsely vegetated, but relatively stable, dunes with big sagebrush. A high percentage of basalt in the sand produces sand that is darker and with strikingly different vegetation than that of the light-colored dunes of the Hanford Dune Field to the southeast of Gable Mountain. These basalt sand dunes are normally quite barren, but a high diversity of annual species was seen in 1995 after unusually high winter and spring rainfall. Each population was invariably associated with Suksdorf's monkey-flower (sensitive). Rosy calyptridium, another California annual that had not been collected north of Harney County, Oregon, was also found in association with loeflingia at several sites. It was also found with one population of sand gilia, an annual species not previously known in Washington.

3.9.5.2.15 Persistent-sepal Yellowcress

Persistent-sepal yellowcress ranges from California north to Washington, distributed in two distinct regions—along the Columbia River in Oregon and Washington and south-central Oregon to northern California. The population on the Hanford Reach is the most vigorous in Washington and perhaps throughout the range of the species. Twenty-two occurrences are found in three counties in south-central and southwestern Washington, all adjacent to the Columbia River. Sixteen of the occurrences are located along nearly forty miles of the Hanford Reach. These populations range from fourteen to more than 200 plants, on approximately 0.01 to 3.0 acres. The WNHP has merged these sixteen populations into one WNHP occurrence.

Persistent-sepal yellowcress is a regional endemic that is considered endangered in Washington and is a federal species of concern (WNHP 1997). In Oregon, it is included on List 1, which contains taxa that are endangered or threatened throughout their range (Oregon Natural Heritage Program 1993). For the last several years, extensive research, monitoring and surveys have been

done in Oregon and Washington; a status report on this species was recently prepared by the WNHP (Salstrom and Gehring 1994).

Persistent-sepal yellowcress grows in damp to wet soils near all types of bodies of water, but in Washington it is restricted to the riparian areas adjacent to the Columbia River near the Hanford Site and below the Bonneville Dam. Populations can be ephemeral due to changes in hydrology. On the Monument, plants are found at or near the lower edge of the vegetated zone on riverbanks in open, lightly vegetated gravel, cobble and sandy areas, especially gravel bars on shallow-water sections. Vegetative cover at these sites is generally sparse.

All along the Columbia River, persistent-sepal yellowcress faces several threats. On the Monument, many of the sites where the populations occur are inundated until mid-summer and may also be inundated daily throughout much of the remainder of the growing season, depending on upstream hydropower project management. According to Harris (1992), flows of less than 100,000 cfs at Priest Rapids Dam are needed to expose populations on the Hanford Reach. These lower flows do not become common until August, and daily higher flows are common throughout the growing season, resulting in regular inundation of the populations even after growth is initiated in August. In addition, all of the new sub-populations are publicly accessible by boaters and other recreational users. At least one sub-population could be threatened by erosion if irrigation use increased on the Wahluke Slope above the White Bluffs. In some locations, the riparian habitat of persistent-sepal yellowcress is being invaded by white mulberry seedlings and shrubs.

3.9.5.2.16 Piper's Daisy

Piper's daisy is a regional endemic that is found only in the Columbia Basin of Washington and is considered sensitive in Washington. Prior to 1994, there were sixty-five known occurrences in Washington, thirty-six of which have not been visited since 1985 (WNHP 1995); seven of these populations were found on the Hanford Site. The 1994 survey found fifteen new populations—ten on the ALE, one on Central Hanford, and four on the Wahluke Unit. Concurrent with TNC surveys, workers at the PNNL also found several new populations on Umtanum Ridge and in the ALE.

Piper's daisy occurs most commonly in the winterfat/Sandberg's bluegrass plant community type and to a lesser extent in the big sagebrush/bluebunch wheatgrass plant community type. The taxon is most common in undisturbed areas of the brush-steppe. It appears that the Rattlesnake Mountain populations are more or less continuous over more than 12,000 acres. A smaller population on Yakima Ridge is less vigorous. The density and extent of the populations varies widely. The dense concentrations are most prevalent on low ridges in the winterfat/ Sandberg's bluegrass plant community type. Two very small populations were located on the

Wahluke Slope south of Saddle Mountain in the Wahluke Unit, also in a winterfat/Sandberg's bluegrass plant community type.

The Rattlesnake Mountain populations are thriving and do not have any present threats. The Wahluke Slope populations are in a highly disturbed habitat that is accessible to the public. Piper's daisy is a sensitive species in the state of Washington.

3.9.5.2.17 Rosy Calyptridium

Rosy calyptridium ranges from central Oregon to California and east to Nevada and south-central Idaho. Before being located on the Hanford Site, the plant was not known in Washington and had not been collected north of Harney County, Oregon; it is considered a state threatened species in Washington. Two populations and several sub-populations of rosy calyptridium were found in Central Hanford north of Gable Mountain in dark, basalt-derived sand and in silt substrate associated with small, subtle depressions or swales. Because the species is an annual, population numbers and exact location is likely to vary from year to year according to weather conditions. It is estimated that there are less than 250 plants, all located within one mile of each other. Because the terrain is flat and relatively undifferentiated, and because plants are not likely to germinate every year, populations may be difficult to relocate. Therefore, marking vulnerable and difficult to relocate populations is recommended. Further surveys are likely to identify additional populations in the vicinity of Gable Mountain.

On the Hanford Site, rosy calyptridium's habitat is gravelly soils and sagebrush shrublands within the big sagebrush/Sandberg's bluegrass community. Vegetation cover at most sites is generally low. Associated plants species include Sandberg's bluegrass and assorted native and exotic annual species. Rosy calyptridium grows in conjunction with Suksdorf's monkey-flower (sensitive) and two other taxa new to Washington, loeflingia and sand gilia.

3.9.5.2.18 Sand Gilia (Great Basin Gilia)

Sand gilia is a sensitive species whose range includes Great Basin areas in Oregon, California, Colorado, Idaho and New Mexico. Before being located on the Hanford Site during the 1995 field season, it was not known in Washington; it is now considered sensitive in Washington State. Seven populations of sand gilia were located at widely varying places on the Hanford Site, including the gravelly bluffs north of Vernita Bridge, the basalt sand dunes north of Gable Mountain, Umtanum Ridge, and the White Bluffs. Although widespread, most populations were small and discrete. One of the White Bluffs populations is the largest known in Washington with several hundred plants.

The habitat preference for sand gilia is open sandy or rocky areas where vegetation is generally low. The plant association is loosely describe as big sagebrush/Sandberg's bluegrass. Weedy species such as cheatgrass and Russian thistle are sometimes sub-dominant. Both habitat and substrate type show substantial variation. On the Hanford Site, small, isolated populations of sand gilia are found in different high-quality habitat areas where there is often an array of rare plant species (Columbia milkvetch, Piper's daisy, Umtanum desert buckwheat, Hoover's desert-parsley, dwarf evening primrose, white eatonella, bristly pectocarya, White Bluffs bladderpod, Snake River cryptantha, Suksdorf's monkey-flower, loeflingia and rosy calyptridium).

3.9.5.2.19 Scarlet Ammannia (Grand Redstem)

Scarlet ammannia is a wetland species that ranges from California to the central United States and Mexico, but that has been reported in Klickitat County, Washington; it is considered threatened in Washington. On the Monument, it is found in sixteen locations along the Hanford Reach in the upper margins of the seasonally inundated zone below the high water mark; these locations are now considered one population. Elevations range from 360 feet to 420 feet, and slopes are generally 1% to 3%.

The riverine wetlands in which scarlet ammannia occurs have been designated riverine emergent non-persistent wetlands. They are completely submerged during the early portions of the growing season (March through June) and submerged periodically during the later portions of the growing season (July through September). These unique wetlands have a very high diversity of native wetland plants and a low cover of weedy plants. Many of the native wetland plants that occur in these wetlands are annuals. Plants associated with this community include rushes, spike rushes, toothcup, scarlet ammannia, and flatsedges.

All previous collections of this species were made before dams were built on the Columbia and Snake Rivers. Changes in the hydrologic regime as a result of upstream hydropower project management, boating, and other recreational uses of these sensitive riparian wetlands pose threats to the high-quality native wetlands. Purple loosestrife could also pose a threat to habitat unless controlled.

3.9.5.2.20 Shining Flatsedge

Shining flatsedge is considered sensitive in Washington where it is peripheral to its main range. It is also included on review lists in Idaho and Oregon. Prior to the 1994 field season, there were nine occurrences in Washington—five of which have not been verified since 1985—including two on the Hanford Site. The species is found along stream banks and other wet, low places in valleys and lowlands; it is tolerant of alkaline conditions. In Washington, shining flatsedge is known exclusively from the more arid regions of the state in riverine wetlands, in small

embayments, and in backwaters of the Columbia River. (See the discussion of scarlet ammannia for details and management issues.) In 1994, shining flatsedge was found in eighteen new locations in wetlands on the Hanford Reach. Based on consultations with the WNHP, it was decided to merge these eighteen subpopulations and the six previous WNHP occurrences into one large population, including approximately forty miles of the Hanford Reach.

3.9.5.2.21 Small-Flower Evening Primrose

Small-flower evening primrose is listed as sensitive in Washington, where it has a scattered distribution in the Columbia Basin. On the Hanford Site, it generally occurs on very dry, often barren, and sometimes disturbed sites. Six populations were located: three on Central Hanford, on and near Gable Mountain and Umtanum Ridge; two on the ALE in the Cold Creek Valley and Rattlesnake Springs; and one on the Saddle Mountain Unit on the gravelly bluffs north of Vernita Bridge in Grant County. All six populations are relatively small.

Small-flower evening primrose populations grow in conjunction with a number of rare plant species, including Umtanum desert buckwheat, dwarf evening primrose, Columbia milkvetch, desert evening primrose, Piper's daisy, sand gilia, loeflingia, and rosy calyptridium.

3.9.5.2.22 Snake River Cryptantha

Snake River cryptantha ranges from central Washington and eastern Oregon to northeastern California and northern Nevada and east throughout the Snake River Plains of Idaho and western Montana, where it generally grows in dry, open sites, often in stony or shale soils. In Washington, it is a sensitive species and is included on List 3 in Oregon (Oregon Natural Heritage Program 1993). Four populations were located on the Hanford Site during a 1994 field survey (one in the ALE and three in the Wahluke Unit). The largest population is located on the sparsely vegetated White Bluffs in the Wahluke Unit; the population is discontinuously eight miles long with many thousands of plants. Associated vegetation includes big sagebrush, Sandberg's bluegrass, winterfat, dwarf evening primrose (threatened), and White Bluffs bladderpod (endangered). Threats to this species are similar to threats to all species found within the White Bluffs—off-road vehicle use, irrigation-related groundwater changes, and agricultural conversion of habitat.

3.9.5.2.23 Suksdorf's Monkey-Flower

Suksdorf's monkey-flower is found throughout the western United States in open, moist or rather dry places, from the valleys and foothills to moderate- or occasionally rather high-elevation meadows in the mountains. Suksdorf's monkey-flower is a sensitive species in

Washington. Washington is considered peripheral to its main range (WNHP 1997); prior to 1995, there were six occurrences in Washington, from five counties in eastern Washington (WNHP 1995). None of these occurrences have been verified since 1985 (WNHP 1995). Prior to the 1995 field survey, no occurrences were known from the Hanford Site. The 1995 survey found six populations in the vicinity of Gable Mountain in dark, basalt-derived sand and silt substrate associated with swales or vernal pools. The size of the new populations ranges from forty to more than 1,300 plants. The depressions in the topography presumably collect a slightly higher amount of precipitation runoff during the winter and spring months. Because of the annual habit of the species and the dynamic, patchy nature of its habitat within the dark sands north and south of Gable Mountain, the actual and potential habitats of Suksdorf's monkey-flower were combined and mapped as a special habitat area (Hall 1998). Three new populations were associated with sets of vernal pools. A yellow starthistle infestation appears to be a problem at some of these pools. Because the terrain is so flat and plants are not likely to germinate every year, there is a concern that some populations may be quite difficult to relocate.

3.9.5.2.24 Toothcup

Toothcup is a threatened wetland species whose full range is from California to Washington, the eastern United States, and South America. It is included on the sensitive list in Montana and List 3 in Oregon. It has an R1 designation in British Columbia. Toothcup was last collected in Washington in 1948, and most collections were made prior to 1900. All of the riverine collections were made before dams were built on the rivers. Its general habitat is wet places and lake and pond margins. On the Monument, it is uncommon, found in five locations in wet ground below the high water mark along the Columbia River (Sackschewsky et al. 1992).

3.9.5.2.25 White Eatonella

White eatonella's main range includes California, Idaho, Oregon, and Nevada (WNHP 1997). In Washington, it is considered threatened; in Idaho it is included on a list of monitor species (taxa that are common within a limited range, as well as taxa that are uncommon but have no identifiable threats). Prior to the 1994 biodiversity inventory, there were no known occurrences on the Hanford Site. All three populations found on the Monument are in the Saddle Mountain Unit in the gravelly bluffs just north of the Columbia River in the vicinity of the Vernita Bridge.

White eatonella's general habitat is dry, sandy, or desert volcanic areas, often with sagebrush. While the substrate at the other Washington occurrences is typically red basalt gravel, the substrate at the Hanford Site populations is open, loose, gray gravel, where it grows in conjunction with dwarf evening primrose (threatened), bristly pectocarya (watch), and sand gilia. The slopes on which white eatonella grow are relatively undisturbed and have a relatively low cover of weedy species. It is possible there are more populations in the Hanford Site.

3.10 Wildlife

The Monument blends a desert environment with one of the largest river complexes in the country, providing an exceptionally wide variety of habitats within a relatively small assemblage of public lands. Each of these two sharply contrasting environments—desert and river—has its own diverse wildlife populations.

3.10.1 Aquatic Wildlife

To address the aquatic wildlife found in the Monument, it is important to first define the basis of support for this wildlife—the aquatic systems available and the primary food sources of plankton and aquatic plants.

3.10.1.1 Aquatic Systems

Natural aquatic habitats in the Monument include the Columbia River that flows along the northern and eastern edges of the Hanford Site, small spring-streams and seeps located mainly on the ALE in the Rattlesnake Hills, and wetland habitats. For an additional discussion of aquatic habitat, see Section 3.9, "Plant Communities," above.

3.10.1.1.1 Columbia River

The Columbia River is the dominant aquatic ecosystem in the Monument and supports a large and diverse array of plankton, benthic invertebrates, fish, and other communities. It is in part because this last free-flowing stretch of the river is so biologically productive, the NPS recommended that it be added to the National Wild and Scenic Rivers System.

No tributaries enter the Columbia River during its passage through the Monument; however, there are several irrigation water return canals that discharge into the river along the Franklin County shoreline. The WB-10 Ponds and Canal empty into the Columbia River near the White Bluffs Boat Launch, the Ringold Springs enter at Ringold, and the Esquetzel Canal enters the river near the southern boundary of the Monument across from McNary National Wildlife Refuge islands. The presence of irrigation drainage ponds on the Wahluke Slope in Grant County indicates that groundwater seepage enters the river along the north shoreline opposite the 100-B/C to 100-D Areas, as well as the eastern shoreline bordering Franklin County.

3.10.1.1.2 Springs and Spring Streams

Small interrupted streams, such as from Rattlesnake and Snively Springs, contain diverse biotic communities and are extremely productive (Cushing and Wolf 1984). Rattlesnake Springs, on the western side of the Monument, forms a small surface stream that flows for about 1.6 miles before disappearing into the ground as a result of seepage and evapotranspiration. Base flow of this stream is about 0.4 cubic feet per second, and water temperature ranges from 36° to 72°. Rattlesnake Springs is of ecological importance because it provides a source of water to terrestrial animals in an otherwise arid part of the Monument. Snively Springs, located farther west and at a higher elevation than Rattlesnake Springs, is another source of drinking water.

Primary productivity at both springs is quite high. Productivity at Rattlesnake Springs is greatest during the spring and coincident with the maximum periphyton standing crop. Seasonal productivity and respiration rates are within the ranges reported for arid-region streams. The major rooted aquatic plant, which in places may cover the entire width of the stream, is watercress. Dense blooms occur and are not lost until a large flash flood occurs. Isolated patches of bulrush, spike rush, and cattail occupy less than 5% of the streambed. Aquatic insect production in the springs is fairly high compared to mountain streams (Gaines 1987). The macrobenthic biota varies from site to site and is related to the proximity of colonizing insects and other factors. The 24 Command Fire of 2000 has had little direct impact on the stream ecology, even though the riparian transect along the lower two thirds of the stream was heavily damaged by the fire (BAER 2000).

Although Rattlesnake Springs is a net exporter of organic matter during much of the growing season, it is subject to flash floods and severe scouring and denuding of the streambed during winter and early spring, making it an importer of organic materials on an annual basis (Cushing and Wolf 1984).

Secondary production is dominated by detritus-feeding collector-gatherer insects (mostly *Chironomidae* and *Simuliidae*) that have multiple cohorts and short generation times (Gaines et al. 1992). Overall production is not high and is likely related to the low diversity found in these systems related to the winter spates that scour the spring streams. There is an indication that insects in these spring streams depend on both autochthonous (originating within the stream) and allochthonous (originating outside the stream) primary production as an energy source, despite significant shading by exotic species of trees and shrubs (Mize 1993).

3.10.1.1.3 Wetlands

Several areas in the Monument are considered wetlands. The largest wetland area is the riparian zone bordering the Columbia River. The extent of this zone varies but includes extensive stands of willows, grasses and other plants. The zone is extensively affected by water-level

fluctuations, which are both seasonal (from precipitation and discharges from upstream water storage dams) and daily (from power generation at dams upstream of the Monument).

Other wetlands can be found within the Saddle Mountain and Wahluke Units. Wetlands in these areas consist of fairly large pond habitat resulting from irrigation runoff. These ponds have extensive stands of cattails and other emergent aquatic vegetation surrounding the open-water regions. They are extensively used as nesting sites by waterfowl and support populations of warmwater fish that have been introduced by the irrigation network.

Some wetlands exist in the riparian zones of some of the larger spring streams on the ALE. These are not extensive and usually amount to less than 2.6 acres in size, although the riparian zone along Rattlesnake Springs is probably about 1.2 miles in length and consists of peach leaf willows, cattails and other exotic plants. The 24 Command Fire killed many of the large trees found along this riparian zone.

3.10.1.2 Plankton

The Columbia River is a very complex ecosystem because of its size and biotic diversity. Streams in general, especially smaller streams, usually depend on organic matter from outside sources (e.g., terrestrial plant debris) to provide energy for the ecosystem. However, large rivers, particularly the Columbia River with its series of large reservoirs, contain significant populations of primary energy producers (e.g., algae and plants) that contribute to the basic energy requirements of the biota. Phytoplankton (free-floating algae) and periphyton (sessile algae) are abundant in the Columbia River and provide food for herbivores, such as immature insects, which in turn are consumed by predators.

Plankton populations in the Hanford Reach are influenced by communities that develop in the reservoirs of upstream dams, particularly Priest Rapids Reservoir, and by manipulation of water levels by dam operations in upstream and downstream reservoirs. Phytoplankton and zooplankton populations at the Hanford Site are largely transient, flowing from one reservoir to another. There is generally insufficient time for characteristic endemic groups of phytoplankton and zooplankton to develop in the Hanford Reach.

3.10.1.2.1 Phytoplankton

Phytoplankton species identified in the Hanford Reach include diatoms, golden or yellow-brown algae, green algae, blue-green algae, red algae, and dinoflagellates. Studies show diatoms are the dominant algae in the Columbia River phytoplankton, usually representing more than 90% of the populations. The main genera included *Asterionella*, *Cyclotella*, *Fragilaria*, *Melosira*, *Stephanodiscus* and *Synedra* (Neitzel et al. 1982a). These originate in the upstream reservoirs

and so are typical of those forms found in lakes and ponds. A number of algae found as free-floating species in the Hanford Reach are actually derived from the periphyton; they are detached and suspended by current and frequent fluctuations of the water level.

Peak concentrations of phytoplankton occur in April and May, with a secondary peak in late summer/early autumn. The spring pulse in phytoplankton density is probably related to increasing light and water temperature rather than to availability of nutrients since phosphate and nitrate nutrient concentrations are never limiting. Minimal numbers are present in December and January. Green algae (*Chlorophyta*) and blue-green algae (*Cyanophyta*) occur in phytoplankton communities during warmer months but in substantially fewer numbers than diatoms. There have not been any phytoplankton studies conducted in the Hanford Reach in recent years.

3.10.1.2.2 Periphyton

Communities of periphytic species (benthic microflora) develop on suitable solid substrate wherever there is sufficient light for photosynthesis and adequate current to prevent sediment from covering the colonies. Production peaks in spring and late summer. The dominant genera are the diatoms: *Achnanthes*, *Asterionella*, *Cocconeis*, *Fragilaria*, *Gomphonema*, *Melosira*, *Nitzchia*, *Stephanodiscusi* and *Synedra*.

3.10.1.2.3 Zooplankton

Zooplankton populations in the Hanford Reach are generally sparse. Crustacean zooplankters are dominant in the open-water regions; dominant genera are *Bosmina*, *Diaptomus*, and *Cyclops*. Densities are lowest in the winter and highest in the summer, with summer peaks dominated by *Bosmina*. Summer densities range up to 4,500 organisms per cubic foot. Winter densities are generally less than fifty organisms per cubic foot (Brandt et al. 1993). *Diaptomus* and *Cyclops* dominate in winter and spring, respectively. There have been no recent studies of zooplankton in the Hanford Reach.

3.10.1.3 Macrophytes

Macrophytes are sparse in the Columbia River because of strong currents, rocky bottoms, and frequently fluctuating water levels. Rushes and sedges occur along the shorelines of the slack water areas, such as the White Bluffs Slough, the slough area downstream of the 100-F Area, and Hanford Slough. Reed canary grass is a common non-native species found along these shoreline areas. Macrophytes are also present along gently sloping shorelines that are subject to flooding during the spring freshet and daily fluctuating river levels (below Coyote Rapids and

the 100-D Area). Commonly found plants include duckweed, native rooted pondweeds, and Canadian waterweed. Where they exist, macrophytes generally have considerable ecological value. They provide food and shelter for juvenile fish and spawning areas for some species of warmwater game fish. However, one macrophyte in particular—Eurasian milfoil, an exotic macrophyte—has increased to nuisance levels and may encourage increased sedimentation of fine particulate matter. These changes could have a significant impact on trophic relationships in the Columbia River.

3.10.1.4 Benthic Organisms/Aquatic Invertebrates

Benthic organisms are found either attached to, or closely associated with, the substratum. These and other aquatic invertebrates are vital parts of ecosystems. They are so responsive to environmental conditions that their patterns of diversity and abundance have been used to develop an index of biological integrity for streams in parts of the United States. On a local note, aquatic insects are a key element supporting the salmon population in the Hanford Reach.

All major freshwater benthic taxa are represented in the Columbia River. Insect larvae such as caddisflies (*Trichoptera*), midge flies (*Chironomidae*), and black flies (*Simuliidae*) dominate; insect larvae numbers were sometimes as high as 2,000 per square foot (Davis and Cooper 1951). The dominant caddisfly species are *Hydropsyche cockerelli*, *Cheumatopsyche campyla*, and *Cheumatopsyche enonis*. Peak larval insect densities are found in late fall and winter, and the major emergence is in spring and summer (Wolf 1976). Stomach contents of fish collected in the Hanford Reach from June 1973 through March 1980 reveal that benthic invertebrates are important food items for nearly all juvenile and adult fish; there was a correlation between food organisms in the stomach contents and those in the benthic and invertebrate drift communities.

To increase understanding of the aquatic invertebrates of the Monument, TNC conducted a biodiversity inventory (Soll et al. 1999). This inventory conducted reconnaissance-level surveys of aquatic invertebrates of the Columbia River, some tributary water sources, and the two spring streams in the ALE and surveyed published literature for historical records of aquatic invertebrates. This was the first study from this area of Washington to examine tributaries to the Hanford Reach. With one exception, the benthic fauna of the four tributaries inventoried represented a microcosm of the river.

The results of this survey and the literature review clearly indicated that the diversity found in terrestrial invertebrate species in the Monument was also found in the aquatic systems. An additional fifty-two taxa of aquatic macroinvertebrates were identified, including twenty-one not previously documented in the Hanford Reach, bringing the number known to 151. Because this was a reconnaissance-level survey with limited sampling, these findings are not likely to represent the full diversity of aquatic insects on the site. This study greatly expanded knowledge of the invertebrate fauna of Rattlesnake Springs and Snively Springs on the ALE, especially of

Trichoptera, *Odonata* and *Hemiptera*. Thirty taxa of benthic invertebrates were collected from Rattlesnake Springs and twelve from Snively Springs, with twenty-five and eight representing new Hanford Site records, respectively. This brings the known total for the two sites to forty-three and twenty-four, respectively.

Other benthic organisms include clams, limpets, snails, sponges and crayfish. Early Hanford studies found crayfish numbers in shallow water areas ranged from 0.2 to 1.1 individuals per square foot of river bottom, with a diet primarily of vegetation (Coopey 1953).

3.10.1.5 Fish

The Hanford Reach represents a nationally and internationally important fisheries resource; Chinook salmon from the Hanford Reach are an integral component of international fish treaties (i.e., harvest quotas) with Canada. However, even though the Chinook salmon is by far the most famous species in the Hanford Reach, there are a wide variety of other fish species important to the ecology of the Monument. Gray and Dauble (1977) listed forty-three species of fish in the Hanford Reach; the brown bullhead, collected since 1977, and the blue catfish, described in 2004, brings the total number of fish species to forty-five (Appendix J).

3.10.1.5.1 Salmonids

The Hanford Reach is significant for the remaining habitat it provides several species of anadromous salmonids. Of special note, the Hanford Reach in the only remnant of the major mainstem spawning habitat complex in the Columbia River system for fall Chinook salmon.[59] Construction of eleven hydroelectric dams on the Columbia River and six dams on the Snake River between 1939 and 1975 blocked access and inundated most mainstem spawning sites historically used by fall Chinook salmon. These fall Chinook represent a relatively healthy population of the most inland fall Chinook salmon stock in the Pacific Northwest and California (Huntington et al. 1996). Up to 80% of the total run of adult fall Chinook salmon returning to the mouth of the Columbia River spawn in the Hanford Reach (Dauble and Watson 1990).

The Hanford Reach also serves as a migration corridor for other species and stocks of anadromous salmonids—sockeye salmon, spring/summer Chinook salmon, coho salmon, and

[59] Hanford Reach fall-run Chinook salmon are of economic and cultural importance to commercial fisheries in British Columbia and southeast Alaska, in-river commercial and tribal fisheries, and ocean and in-river sport fisheries. This stock is also a principal component of the international Pacific Salmon Treaty between the United States and Canada. As a result, Hanford Reach fall-run Chinook are subject to management recommendations by the Pacific Salmon Commission developed pursuant to the United States–Canada Pacific Salmon Treaty of 1999, management recommendations developed by the Pacific Fishery Management Council, and management agreements and plans under U.S. v. Oregon (Columbia River Fish Management Plan).

steelhead trout—and provides important rearing habitat for juvenile steelhead trout and sockeye salmon from upstream production areas.[60] These species are of considerable economic importance to the Pacific Northwest.

Steelhead trout also spawn in the Hanford Reach. The steelhead fishery in the Hanford Reach (State Route 395 Bridge to Priest Rapids Dam) consists almost exclusively of summer-run fish. The WDFW estimates sport catch for the 1998–1999 season (the last numbers available) as 1,066 fish. About 90% of this harvest occurred from May through July (WDFW 2000). The majority of these fish (98%) were marked hatchery fish.

Although the fall Chinook population is considered healthy, it, and all other anadromous fish runs, are severely impacted by river fluctuations associated with upstream dam operations.[61] Of primary concern are impacts to rearing juvenile fall Chinook. Juvenile fall Chinook salmon, as well as other resident and anadromous fish species, use shallow, low-velocity nearshore areas for rearing, feeding, cover and protection from predators. The highly unnatural streamflow fluctuations that occur in the Hanford Reach due to upstream dam operations (load following) are known to cause significant mortality of juvenile fishes and macroinvertebrates. Typical project operations result in fluctuations as great as 6.9 feet/hour and 13-14 feet in a 24-hour period in the Priest Rapids Dam tailrace during the fall Chinook salmon emergence and rearing period (Nugent et al. 2002). When streamflows drop, rearing fish can be either stranded on gently sloped shorelines and gravel bars, or entrapped in shallow depressions created by the receding water (Anglin et al. 2006; Geist 1989; Wagner 1995; Ocker 1996;, Nugent et al. 2002). Mortality results from direct stranding and desiccation on the substrate, entrapment in isolated pools and resulting lethal water temperatures, and predation on fish trapped in pools. Annual loss estimates for juvenile fall Chinook salmon from stranding or entrapment ranged from approximately 45,000 to 1,630,000 dead fish per year between 1999 and 2003 (Nugent et al. 2002; Anglin et al. 2006). These loss estimates were developed for an 8.7-mile section of the Hanford Reach. A comprehensive survey for the entire Hanford Reach, including the original survey area, was conducted in 2003. The reduced monitoring area mortality estimate was 155,000 dead fish, and the mortality estimate for the entire Hanford Reach was approximately

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[60] In May 2004, the NOAA-Fisheries (then the National Marine Fisheries Service) issued a Biological Opinion related to the continuing operation of the Priest Rapids Hydroelectric Project, which was later adopted by the FERC. The Biological Opinion includes a list of forty alternatives or actions that the Grant PUD needed to take to avoid jeopardizing Upper Columbia River spring Chinook salmon. Of note, the list included the immediate funding and implementation of the White River and Nason Creek spring Chinook salmon supplementation programs and required establishment of the Priest Rapids Coordinating Committee, which is responsible for determining program adjustments.

[61] The Hanford Reach Fall Chinook Protection Program, formalized in April 2004, was developed by the Chelan, Douglas and Grant County PUDs; BPA; WDFW; NOAA-Fisheries; and CCT. Controlling river flows to protect fall Chinook impacts the timing of hydropower produced at all seven dams upstream from the Hanford Reach. The Grant PUD estimates that the cost of the Hanford Reach Fall Chinook Protection Program averages $4.3 million per year in lost power production for the Priest Rapids Hydroelectric Project.

1,300,000. These estimates include only direct mortalities and do not account for delayed mortality of fish found in entrapments that were still alive, or fish that had been removed by avian and terrestrial predators.

Streamflows in the Hanford Reach are intentionally managed at Priest Rapids Dam during the fall-run Chinook spawning season (October–November) with the stated goal of confining spawning activity to lower river elevations.[62] This management action results in lower daytime flows that range from approximately 45,000 to 70,000 cfs. The corresponding nighttime flows range from approximately 150,000 to 200,000 cfs to evacuate Priest Rapids Pool. As a result, suitable spawning habitat is shifted to different areas twice every day, primarily as a function of the wide range of depths and velocities associated with day/night streamflow conditions. This management strategy was developed based on the results of a monitoring study conducted on Vernita Bar (Chapman et al. 1986) and did not include observations for the majority of the spawning sites downstream of Vernita Bar. The impacts of this management strategy on spawning behavior, carrying capacity, redd superimposition, and overall productivity in the Hanford Reach needs further study.

Streamflows are also managed at Priest Rapids Dam during the fall Chinook rearing season (March through mid-June) to control flow fluctuations that result from electrical power demand (load following; Hanford Reach Fall Chinook Protection Program 2004). However, the target hourly flow fluctuations specified cause stranding and entrapment of both juvenile fall-run Chinook salmon and resident fish species. In addition, water level fluctuations alter the amount of juvenile fall-run Chinook rearing habitat on an hourly basis, possibly stimulating downstream movement at an inappropriate time and displacing juveniles into less desirable habitat in the McNary Reservoir.

3.10.1.5.2 Shad

American shad, another anadromous species, may also spawn in the Hanford Reach. The upstream range of the shad has been increasing since 1956 when less than ten adult shad ascended McNary Dam. Since then, the number of shad ascending Priest Rapids Dam has risen to many thousands each year, and young-of-the-year fish have been collected in the Hanford Reach. Shad are not dependent on the same conditions that are required by the salmonids for spawning and apparently have found favorable conditions for reproduction throughout much of the Columbia and Snake Rivers.

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[62] Grant PUD, the owner of the Priest Rapids Hydroelectric Project, reached an agreement in December 2005 with the DOI (including the FWS), NOAA-Fisheries, WDFW and CCT on issues related to steelhead; spring, summer and fall Chinook salmon; sockeye salmon; and coho salmon. (An agreement was reached with the Yakima Nation on August 14th, 2006.) This agreement has been submitted to the FERC and is expected to be recognized in the terms of the new license for the Priest Rapids Project.

3.10.1.5.3 White Sturgeon

The Hanford Reach also provides significant breeding habitat for several resident fish, such as the white sturgeon (*Acipenser transmontanus*). The white sturgeon is a long-lived species reaching up to fifteen feet in length and 1,000 of more[63] that requires swiftly flowing water to reproduce. White sturgeon spawning habitat downstream of the Hanford Reach is limited to small areas just below each hydroelectric project. Within the Hanford Reach, white sturgeon spawning has been recently documented just below Priest Rapids Dam and at a second location above the Vernita Bridge (NPS 1994). Other locations are probable (Fickeisen 1980a). The Hanford Reach and the lower Columbia River downstream of Bonneville Dam support the largest white sturgeon populations in the Columbia River system.

3.10.1.5.4 Other Fish Species

Other fish of importance to sport fishermen are mountain whitefish, smallmouth bass, crappie, catfish, walleye, and yellow perch. In addition to white sturgeon, mountain whitefish (*Prosopium williamsoni*) and sandroller (*Percopsis transmontana*) are two native species that may be present in much higher numbers in the Hanford Reach than in impounded areas.

Large populations of rough fish are also present, including carp, redside shiner, suckers, and northern pikeminnow (formerly known as squawfish). Because northern pikeminnow feed on juvenile salmon, the WDFW has established a bounty program on adult pikeminnow to bolster salmon runs. Northern pikeminnow removed from the Hanford Reach are usually turned in at bounty stations located at Columbia Point in Richland and at the Vernita Bridge Rest Area.

3.10.2 Riparian Wildlife

Riparian areas provide nesting and foraging habitat and escape cover for many species of birds and mammals. Shoreline riparian communities are seasonally important for a variety of species. Willows trap food for waterfowl (e.g., Canada geese) and birds that use shoreline habitat (e.g., Forster's terns), as well as provide nesting habitat for passerines. Terrestrial and aquatic insects are abundant in emergent grasses and provide food for fish, waterfowl and shorebirds.

Numerous bird species occasionally use riparian areas, while other species are fully dependent on those areas—common species include American robins, black-billed magpies, song sparrows, and dark-eyed juncos. Upland gamebirds that use this habitat include ring-necked pheasants and

[63] These are historic numbers. Fish of this size are rare—if not non-existent—today, although there are reports of sturgeon this size in Hells Canyon on the Snake River.

California quail. Predatory birds include common barn owls and great horned owls. Species known or expected to nest in riparian habitat include Brewer's blackbirds, mourning doves, black-billed magpies, northern orioles, lazuli buntings, eastern and western kingbirds, and western wood peewees. Bald eagles have wintered in the Hanford Site since 1960 and use riparian trees for perching and roosting. Great blue herons and black crowned night herons are associated with trees in riparian habitat along the Columbia River and use groves or individual trees for perching and nesting. On occasion, great blue herons have constructed nests in the large metal powering towers that are present on the shores of the Columbia River.

The Monument is located in the Pacific Flyway, and the Hanford Reach serves as a resting area for neotropical migrant birds, migratory waterfowl, and shorebirds (Soll et al. 1999). During the fall and winter months, ducks (mallard, pintail, ring-necked, canvas back, bufflehead, goldeneye) and Canada geese rest on the shorelines and islands along the Hanford Reach. The area between the Hanford town sites and Vernita Bridge is closed to recreational hunting, and large numbers of migratory waterfowl find refuge in this portion of the river. Other species observed during this period include American white pelicans, egrets, double-crested cormorants, coots, and common loons.

Mammals occurring in riparian areas of the Monument include rodents, bats, furbearers (e.g., mink and weasels), porcupines, raccoons, skunks and mule deer. River otters are occasionally observed in the Hanford Reach. Beavers and muskrats rely on shoreline habitat for dens and foraging. In the spring, mule deer use Columbia River islands for fawning and nursery areas. During the summer, mule deer rely on riparian vegetation for foraging. The Columbia River and Rattlesnake Springs provide foraging habitat for many species of bats which feed on emergent aquatic insects, including myotis, small-footed myotis, silver-haired bats, and pallid bats.

3.10.3 Terrestrial Wildlife

The shrub and grassland habitat of the Monument supports a variety and abundance of wildlife that is surprising given the harsh climate. For a discussion of terrestrial wildlife habitat(s), see Section 3.10, "Plant Communities," above.

3.10.3.1 Terrestrial Invertebrates

Many species of insects occur throughout all habitats in the Monument. Butterflies, grasshoppers and darkling beetles are among the most conspicuous of the approximately 1,500 species of insects that have been identified from specimens collected (Soll et al. 1999). The actual number of insect species may reach as high as 15,500. A total of 1,509 species-level identifications were completed in 1999, and 500 more are expected. Recent surveys performed by TNC included the collection of 40,000 specimens and have resulted in the identification of

43 new taxa and 142 new findings in the state of Washington (Soll et al. 1999). The high diversity of insect species reflects the size, complexity and relatively undisturbed quality of the shrub-steppe habitat.

Because of their extraordinary diversity and intimate interactions with vegetation, insects are one of the most sensitive measures of ecosystem quality and function; however, data is often lacking with which to make comparative judgments among sites. In 1994 and 1995, terrestrial invertebrate inventories were conducted, concentrating on particular insect groups, including leafhoppers and their relatives, true bugs, beetles, bees and wasps, true flies, and butterflies and moths. During 1996 and 1997, inventory efforts concentrated on moths and other night-active insects attracted to light traps and on butterflies. Surveys in 1998 broadened the sampling methods to include pitfall traps.

These five years of insect inventory work in the Hanford Site represent the most intensive survey of its kind of any large geographic region in Washington and one of the few studies of its type conducted in the Pacific Northwest. Almost 40,000 specimens have been collected and identified or made available for identification. Thus far, 1,509 species-level identifications have been completed, and at least 500 more are expected.

Through the insect biodiversity inventory, a total of forty-one species and two subspecies new to science have been identified and designated by world-recognized authorities. Additionally, numerous other specimens that have been collected but not yet identified may represent species new to science. At least 142 species were not previously known to exist in Washington State. The key point about insect diversity in the Monument, however, is not that any single species is found here and no place else; rather, it is that so many species, including rare or rarely collected species, are found here. These findings indicate that the Monument still retains an assemblage of microhabitats large enough to support what at one time was a fauna typical of the arid interior West.

Of particular interest are the butterflies and moths. Forty-nine taxa of butterflies have been identified; eight of these taxa are identified as monitor species by the state of Washington (WDFW 1998). To date, a total of 318 species of moths have been collected; twenty of these species are new to science, and fourteen species represent new state records for Washington. Butterflies and moths (*Lepidoptera*) are one of the few groups of insects that are commonly included in biodiversity studies. Although other groups of insects offer as much potentially valuable information, butterflies and moths are indeed noteworthy for their use in estimating diversity. This is primarily because of their association with host plants. With few exceptions, butterflies and moths are plant feeders, and many are monophagous (i.e., one host plant used as food) or restricted to a limited number of related host plants. Thus, a diverse lepidopteran fauna often corresponds to a diverse flora.

Shrub-steppe habitat has a relatively distinctive arthropod fauna, which appears to vary with the amount of disturbance and degradation within the habitat. Based on invertebrate collections thus

far, it appears that shrub-steppe habitats in the Wahluke and Saddle Mountain Units are more degraded than that of the ALE. Several arthropod species that were encountered in habitats south and west of the Columbia River (e.g., snow scorpionflies [*Mecoptera: Boreidae*] and a winter scarab [*Aphodius*] new species [*Coleoptera: Scarabaeidae*]) were not found north of the river. The species richness of ground-dwelling beetles is also less in the Wahluke and Saddle Mountain Units. It should be noted that invertebrate collections on the ALE were made prior to the 2000 wildfire that severely altered some shrub-steppe habitats (Evans et al. 2002). Fire has been associated with reductions in total invertebrate family richness as well as in total taxa richness of predatory, detritus-feeding, and ground-dwelling invertebrates in shrub-steppe environments at Hanford (Karr 2000).

The Hanford Site likely represents the closest approximation to a pre-European colonization insect fauna as can be found in eastern Washington. The diverse insect fauna of the Monument was one of the resources called out in the Presidential Proclamation establishing the Monument. The source of the Monument's insect diversity and unique character can be attributed to the size, diversity and relatively undisturbed condition of its native vegetation and other natural habitat characteristics. Several groups of insects appear to be associated with areas of extensive microbiotic soil crusts; mite and *Collembola* (springtail) fauna are abundant where the crust is intact and are virtually nonexistent where the crust has been destroyed. The distribution of snow scorpionflies exhibits the same contrast: The larvae of these small insects feed on moss and are not found in areas where the crust has been degraded or destroyed.

Entomological studies of the site continue to indicate that the Hanford Site is unusual in its lack of introduced or pest species and in its abundance of native taxa. For example, wild bees are the most commonly encountered *Hymenopterans* in the Monument, an indication of the predominance of native vegetation on the site. In the surrounding urban and agricultural landscape, the introduced domesticated honeybee is most common. Agricultural pest species, such as corn earworm, alfalfa looper, celery looper, and numerous cutworms, make up the bulk of trap samples outside of the Hanford Site; these taxa are collected only in small numbers in the Hanford Site. The native arthropod fauna of the Hanford Site provides one of the few remaining areas where potentially beneficial native insects may be sought and, perhaps, found.

Despite extensive and fruitful entomological diversity studies, very little is known concerning the arthropod fauna of the Monument. Species new to Washington State and new to science continue to be found. Such discoveries are likely to continue and accelerate if longer-term studies can be conducted, especially if surveys are focused on less-studied taxa. Large numbers of specimens in some of the lesser-known groups (e.g., spiders) have been collected and processed, and it is hoped that the identification and evaluation of these organisms will add significantly to an understanding of the biological diversity of the Monument. For these reasons, it is important to maintain representative native plant communities and generalized habitats, such as the few springs and riparian zones present in the Monument.

3.10.3.2 Amphibians and Reptiles

Before 1995 no comprehensive surveys had been completed on the herpetofauna of major portions of the Hanford Site. In 1995 and 1998, inventory efforts focused on a preliminary site-wide inventory to document the amphibian and reptile species present and the habitats they are using, with follow-up surveys of promising areas. An emphasis was placed on locating species of conservation concern. A total of twelve species of reptiles and five species of amphibians have been documented in the Monument (Appendix I).

Four species of amphibians and nine species of reptiles were found during the 1995 inventory. Three species—Woodhouse's toad (*Bufo woodhousii*), tiger salamander (*Ambystoma tigrinum*), and night snake (*Hypsiglena torquata*)—are Washington State monitor species (WDFW 1998). One species—the northern sagebrush lizard (*Sceloporus graciosus graciosus*)—is a federal species of concern (FWS 1998). The tiger salamander was documented in the Hanford Site for the first time in 1998. Compared to other inventory research areas, few rare amphibian and reptile species were located by the inventory effort. Significantly, however, each of the typical shrub-steppe species was present in appropriate abundance, in sharp contrast to their absence or decline in other areas. Especially noteworthy was the linkage of sagebrush lizard with areas of mature sagebrush and sandy soils.

The side-blotched lizard is the most abundant reptile species occurring in the Monument. Short-horned and sagebrush lizards are reportedly found in the Monument but occur infrequently. The most common snake species include gopher snake, yellow-bellied racer, and Pacific rattlesnake. The Great Basin spadefoot toad, Woodhouse's toad, Pacific tree frog, tiger salamander, and bullfrog are the only amphibians found in the Hanford Site (Soll et al. 1999; Brandt et al. 1993).

3.10.3.3 Birds

The FWS is the principal federal agency charged with protecting and enhancing the populations and habitat of more than 800 species of birds that spend all or part of their lives in the United States. Additionally, the primary responsibility for administrating the Migratory Bird Treaty Act of 1916, its amendments, and subsequent acts lies with the FWS. Because migratory birds often cross geographical and political boundaries, their conservation depends upon actions taken by the FWS in concert with a host of participating partners, both domestic and foreign, public and private. The primary goal is to conserve migratory bird populations and their habitats and to ensure that the public continues to enjoy both consumptive and non-consumptive uses of migratory birds and their habitats (see pacific.fws.gov/mbsp/).

In addition, the FWS has been an integral partner in development of plans for bird conservation efforts under the North American Bird Conservation Initiative (NABCI). The NABCI is a tri-national initiative of the United States, Canada and Mexico to develop and implement plans for

the long-term health of all bird species in all habitat regions of North America. To facilitate the initiative, the natural habitats of the continent have been mapped into sixty-seven Bird Conservation Regions (BCR). The resulting spatial framework has been in use by the NABCI since late in 1999. Its units have nothing to do with political boundaries. Rather, each comprises a set of related and contiguous ecosystems. Region 9, the Great Basin/Columbia Basin Region, for example, is a large and complex ecological region that stretches from southern Nevada to the central interior of British Columbia. The Monument is part of BCR Region 9.

Birds are conspicuous components of the biota of an area. Their visibility, variety and abundance appeal both to scientific investigations of biodiversity and to the aesthetic, recreational and conservation interests of the general public. Thus, compared to other taxonomic groups, bird status, trends and distribution within a particular geographic area tend to be relatively well documented. Furthermore, the habitat factors responsible for species presence, absence and abundance are better understood for birds than for most other groups. These characteristics make bird inventories particularly informative about both the ecological quality of a site and its conservation importance relative to a broader region (TNC 1999).

Approximately 258 species of birds have been documented on or near the Monument, thirty-six of which are common and forty are accidental visitors (see Appendix K). The Monument provides habitat for year-round residents, migratory species that breed on the site, winter residents, and migrants that are passing through to or from breeding grounds. The upland habitats of the Monument contain regionally significant breeding populations of steppe- and shrub-steppe-dependent birds and are important to bird conservation in the Columbia Basin Ecoregion. Additionally, riparian/wetland habitat areas (including springs and seeps) contain the highest diversity of bird species in the Monument. These areas provide important stopover habitat for migratory birds, as well as breeding and post-breeding habitat for many resident species. Finally, riverine habitat along the Hanford Reach, such as islands, bluffs and sandbars, are important for a variety of nesting birds, including swallows, falcons, owls, geese, gulls, terns and waterbirds, as well as wintering habitat for a variety of species.

Mature sagebrush stands are perhaps the most important habitat in the Monument because large blocks of sagebrush in good condition are a dwindling resource in the Columbia Basin Ecoregion. Many bird species (forty-one, Soll et al. 1999) that depend on big sagebrush/ bunchgrass or bunchgrass habitats are considered sagebrush obligate species (see Table 3.2). This means that they require sagebrush to complete some part their life cycle (i.e., breeding, nesting, successful reproduction). Many species rely on sagebrush as part of their diet or for nesting, resting or hiding cover. Some species, such as the western sage grouse, now a federal candidate species for listing as threatened, were commonly hunted in the recent past.[64] Non-

[64] Greater sage grouse were historically abundant in the Hanford Site; however, populations have declined since the early 1800s because of the conversion of sagebrush-steppe habitat. Although surveys conducted by the WDFW and PNNL during late winter and early spring 1993, and biodiversity inventories conducted by TNC in 1997, did not observe greater sage grouse in sagebrush-steppe habitat at ALE, sage grouse have been observed in 1999, 2000

game species, such as the state candidate loggerhead shrike and sage sparrow, have fallen victim to habitat conversion and degradation.[65] The Monument provides a regional stronghold for several species of these migratory birds. Other examples of sagebrush obligate species that have significant populations in the Monument include Brewer's sparrows and sage thrashers, which are more common in the three-tip sagebrush communities at higher elevations. Although not generally considered a sagebrush-obligate species, horned larks and meadowlarks are the most abundant breeding birds in the sagebrush/bunchgrass habitats.[66]

Table 3.2. Steppe and Shrub-Steppe Obligate Species of the Columbia Basin Ecoregion.

Common Name	Scientific Name	Federal Status	State Status	Sagebrush Obligate	Hanford Abundance
Insects					
Sheridan's green hairstreak	*Callophyrys sheridanii neoperplexa*		Monitor		Rare
Reptiles					
Striped whipsnake	*Masticophis taeniatus*		Candidate	Yes	Rare
Birds					
Brewer's sparrow	*Speizella breweri*			Yes	Common
Sage grouse	*Centrocercus urophasianus*	Former candidate	Candidate	Yes	Rare
Sage sparrow	*Amphispiza belli*		Candidate	Yes	Common
Sage thrasher	*Oreoscoptes montanus*		Candidate	Yes	Rare
Mammals					
Pygmy rabbit	*Brachylagus (Sylvilagus) idahoensis*	Former candidate	Endangered	Yes	Extirpated
Sagebrush vole	*Lagurus (Lemmiscus) curtatus*		Monitor	Yes	Uncommon
Washington ground squirrel	*Spermophilus (Citellus) washingtoni*		Monitor		Undocumented

Native grasslands of the Columbia Basin Ecoregion have declined more than 85% since European settlement and have been described as an endangered ecosystem (Noss 1995). The

and 2002. The area around and including the Monument is identified as a unit for the recovery of sage grouse in the Washington State Sage Grouse Recovery Plan (WDFW 2004).

[65] The Saddle Mountain and Wahluke Units together provide the greatest contiguous tract of suitable, occupied habitat for breeding sage sparrows in the state of Washington (Stepniewski 1994).

[66] Surveys conducted during 1993 (Cadwell 1994) reported the occurrence of western meadowlarks and horned larks more frequently in shrubland habitats than in other habitats in the Hanford Site.

large expanses of native bunchgrass in the Monument are a unique habitat and provide hunting, nesting and resting areas for a number of bird species. Native bunchgrass habitat is used for foraging by a variety of raptors, including Swainson's hawks, golden eagles, prairie falcons, short-eared owls, red-tailed hawks, ferruginous hawks, sharp-shinned hawks, and rough-legged hawks, among others.[67] Meadowlarks, horned larks, and grasshopper sparrows, are some of the ground-nesting birds that are commonly found in bunchgrass habitat in the Monument. Burrowing owls and northern harriers have also been documented nesting and feeding in bunchgrass habitat. Long-billed curlews also prefer grassland habitats for nesting and foraging. Common upland gamebird species that occur in shrub and grassland habitat include chukar, gray partridge, California quail, and ring-necked pheasant. Chukars are most numerous in the higher elevations on the Hanford Site.

Riparian habitat is a scarce but important resource for birds in the Monument. The sharp contrast with the adjacent shrub-steppe habitat, the presence of trees, and the abundant cover make these areas focal points for predator and prey. Although the total area occupied by riparian habitat is small, the avian diversity there is higher than the surrounding shrub-steppe. Riparian habitats are used by neotropical migrants—such as western wood peewees, Say's phoebes, and western kingbirds—and resident downy woodpeckers and northern flickers. Trees are rare in the Monument landscape and therefore provide an important resource for a number of birds. Raptors will perch, hunt from, or nest in trees in the riparian zone, or they may be attracted by the presence of prey species. Barn owls, long-eared owls, great-horned owls, red-tailed hawks, sharp-shinned hawks, American kestrels, and Swainson's hawks regularly use riparian zones. Chukar, California quail, and mourning doves find abundant cover from predators in the riparian zones. Red-winged and yellow-headed blackbirds breed along watercourses. Songbirds documented using the Monument's riparian zones include ruby-crowned and golden-crowned kinglets; warbling vireos; and orange-crowned, yellow-rumped, and MacGillivray's warblers, among others. In the winter, riparian zones are used by dark-eyed juncos, white-crowned sparrows, Townsend's solitaires, and other species (LaFramboise and LaFramboise 1998).

Riverine habitat along the Hanford Reach is used extensively by mallards, Canada geese, and other waterfowl for wintering and the island habitats for nesting. Great blue herons, great egrets, black-crowned night-herons, and other water-related birds have been noted using the river corridor and islands. Double crested cormorants, American white pelicans, several species of gulls, and terns also use these areas. This riverine habitat provides essential wintering habitat for bald eagles (federally threatened), American white pelicans, and many species of waterfowl.

Thirty-eight bird species recorded during recent surveys, including eighteen known to breed within the Monument, are considered species of conservation concern at a state or federal level,

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[67] In 1994, nesting by red-tailed, Swainson's, and ferruginous hawks included forty-one nests located across the Hanford Site on high-voltage transmission towers, trees, cliffs and basalt outcrops. In recent years, the number of breeding ferruginous hawks (a Washington State threatened species) in the Hanford Site has increased, a result, in part, to their use of steel powering towers in the open grass and shrubland habitats for nesting.

or are known or suspected to be declining. Several of these species are closely associated with sagebrush/grassland habitats. Further, many birds, especially migratory species, rely on riparian vegetation or other water-based habitats for some or all of their life cycle. These species have declined as the Columbia River has been converted into a series of reservoirs, and the vegetation along smaller creeks, springs and rivers has been degraded by agriculture and domestic livestock grazing. The remaining habitats offered by the Monument play an important role in preserving this species into the future.

3.10.3.4 Mammals

The Monument provides for an abundance of mammals, although the number of species (species diversity) is limited as compared to more temperate habitats. A total of forty-four species of mammals have been conclusively documented in the Monument; however, it is quite possible that others (such as additional bat species) use the refuge but have not yet been documented. There was a reported sighting of a cougar on the ALE by biologists during an elk relocation effort in March 2000, supplementing other anecdotal accounts of cougar in the Hanford Site. Species present include large game animals such as Rocky Mountain elk and mule deer; predators such as coyotes, bobcats and badgers; and small herbivores like deer mice, harvest mice, ground squirrels, voles, black-tailed jackrabbits, and the Great Basin pocket mouse, the most abundant mammal in the Monument.

There are twelve mammal species potentially present in the Hanford Site that are identified as species of conservation concern (see Tables 3.3 and 3.4) and several species that are important because of their status as game animals (elk, mule deer, and white-tailed deer) or their significance to local Native American tribes. Recent inventories by TNC (1995–1999) specifically targeted searches for species that had not been previously documented in the Hanford Site, as well as federal and state species of concern.

Small mammals present in the Hanford Site have been well documented (TNC 1999; Downs et al. 1993; Fitzner and Gray 1991; Rickard and Poole 1989). Fourteen native, non-bat, small mammal species were documented during biodiversity inventories (TNC 1999). Surveys for Ord's kangaroo rat, Merriam's shrew, and pygmy rabbit have, to date, been negative. However, potential habitat for these species exists in the Monument. In 1998, for example, inventory work confirmed the presence of the state candidate Washington ground squirrel just north of the crest of the Saddle Mountains and along State Route 24 on the Wahluke Slope. This was the first time this species has been documented to occur in the Monument. Still, even previously documented species (i.e., Merriam's shrew, sagebrush vole, and Townsend's ground squirrel) seem to be limited in their distribution in the Monument. The limited distribution of Merriam's shrew and sagebrush vole demonstrates the importance of the ALE, Umtanum Ridge, and other remnant high-quality big sagebrush/bluebunch wheatgrass and three-tip sagebrush plant communities.

Despite the limited results regarding the number of species observed, many findings from the small mammal inventory are noteworthy. By habitat area/plant community type, capture rates and biodiversity were highest in native shrub-steppe, in particular the bitterbrush/Indian ricegrass dune complex and big sagebrush/needle-and-thread communities. Both of these community types have received the highest protection priority ranking assigned by the WNHP (WDNR 1995). The capture rates within these two community types were eight to twelve times higher than the rate observed in disturbed communities dominated by cheatgrass. Native habitats provide greater structure for thermal and hiding cover, as well as greater forage availability and nutrition (foliage and seed crops), to mammals than disturbed communities.

A total of nine bat species are documented in the Hanford Site. It is possible that one other species also occurs; the California myotis has been noted as possibly occurring in the Hanford Site. The western pipistrelle, pallid bat, and western small-footed myotis are identified as species of conservation concern by the FWS and the WDFW (1998). The White Bluffs, Columbia River, open water, mature trees, and all cliff structures are important for bats at in the Monument.

Deer and elk are important for recreational hunting opportunities and are culturally important to Native American tribes. Other tribally important species include, but are not limited to, American beaver, muskrat, common porcupine, and coyote. These larger mammal species also depend on mature shrub habitats for thermal cover in both winter and summer (shade), and many use mature shrub for forage (browse). Grasslands are critical for grazing animals, such as elk, and natural springs are an extremely important habitat for providing fresh water to the majority of mammal species in the Monument.

3.10.4 Unique/Rare Habitats and Associated Wildlife

One of the greatest values of the Monument is its blend of a wide variety of habitats within its desert environment. Unique/rare habitats in the Monument include bluffs, dunes and islands. In addition, while not rare within the Columbia Basin, the White Bluffs, Umtanum Ridge, and Gable Mountain include rock outcrops that occur infrequently on the Hanford Site. Plant communities dominated by buckwheat and Sandberg's bluegrass most often occupy these basalt outcrops.

Bluffs provide perching, nesting, and escape habitat for several bird species on the Monument. The White Bluffs and Umtanum Ridge provide nesting habitat for prairie falcons, red-tailed hawks, cliff swallows, bank swallows, and rough-winged swallows. In the past, Canada geese used the lower elevations of the White Bluffs for nesting and brooding. Bald eagles use the White Bluffs for roosting. Bluff areas provide habitat for sensitive species (i.e., peregrine falcons) that otherwise may be subject to impact from frequent or repeated disturbance. Trees that do not normally occur in arid steppe habitat supply nesting, perching and roosting sites for

bird species; raptors like ferruginous and Swainson's hawks use trees for breeding in areas that previously did not support breeding populations. Ferruginous hawks also nest on electrical transmission line towers.

Dune habitat in the Monument is unique in its association with the surrounding shrub-steppe vegetation type. The uniqueness of the dunes is noted in its vegetation component as well as the geologic formation. Snow buckwheat and Sandberg's bluegrass/cheatgrass communities dominate the large dune area north of the Energy Northwest complex along the Columbia River shoreline. Here, the terrain of the dune habitat rises and falls between ten and sixteen feet above ground level, creating areas that range from 2.5 to several hundred acres in size. These dunes are vegetated by bitterbrush, scurfpea and thickspike wheatgrass. The dune fields provide habitat for mule deer, burrowing owls, and coyotes, as well as many transient species, and are very important for maintaining large populations of sagebrush lizard in the Monument.

Islands afford an additional arrangement of upland and shoreline habitat for avian and terrestrial species. Island habitat accounts for approximately 1.8 square miles and 39.9 miles of river shoreline within the main channel of the Hanford Reach. Islands vary in soil type and vegetation and range from narrow cobble beaches to extensive dune habitats, further increasing habitat complexity. Characteristic shoreline vegetation on the islands includes willow, poplar, Russian olive, and mulberry.[68] Species occurring on the island interior include buckwheat, lupine, mugwort, thickspike wheatgrass, giant wildrye, yarrow and cheatgrass.

Except for several plant species, the islands accommodate many of the same wildlife species that occur in mainland habitats. Islands provide resting, nesting and escape habitat for waterfowl and shorebirds. Use of islands for nesting by Canada geese has been monitored since 1950. While fluctuating annually, the nesting success of Canada geese is quite high and is attributed to restricted human use of islands during the nesting season, suitable substrate, and adequate forage and cover for broods (Eberhardt et al. 1989). In recent years, geese have used the downstream islands in the Hanford Reach for nesting as a result of coyote predation in the upper islands. Islands also accommodate colonial nesting species, including California gulls (*Larus californicus*), ring-billed gulls (*Larus delawarensis*), and Forster's terns (*Sterna forsteri*). Island areas ranging from 0.05 to 0.08 square miles accommodate colonial nesting species that may range in population size of upward of 2,000 individuals. Mule and white-tail deer also use the islands during calving as protection from coyotes. Unfortunately, operation of the Priest Rapids Dam upstream of the Hanford Reach creates daily and seasonal river level fluctuations that may limit community structure and overall shoreline species viability along the shoreline interface.

[68] Before regulation of river flows by dams, trees were not found along river shoreline habitat, with the exception of small willows.

3.11 Threatened and Endangered Species

T&E plants and animals identified in the Monument, as listed by the federal government (50 CFR 17) and Washington State (WDFW 2004, WNHP 2002), are shown in Table 3.3 (see also Map 18, Section 3.9.5 for plants, and Footnote 51 on page 3-54). The bald eagle (threatened), upper Columbia River steelhead (endangered), and spring-run Chinook salmon (endangered) are currently the only species found on the federal list of threatened and endangered species that are regularly present in the Monument. The Columbia Basin pygmy rabbit was emergency listed as federally endangered in November 2001; however, they may be extirpated from the Monument. No other federally listed threatened or endangered species are known to occur regularly in the Monument. While Washington State-listed T&E species include all of the species included in Table 3.4, several additional species of both plants and animals are under consideration for formal listing by the federal government (persistent-sepal yellowcress, Umtanum desert buckwheat, and White Bluffs bladderpod) and/or the state. The FWS reviews the status of candidate species for ESA listing on an annual basis. The results of these reviews are posted on the FWS homepage (www.fws.gov). Anadromous fish are reviewed and listed by the National Oceanic and Atmospheric Administration (NOAA) Fisheries (www.nwr.noaa.gov).

The bald eagle is a regular winter resident and forages primarily on waterfowl and spawned salmon along the Columbia River; an average of forty eagles use the Hanford Reach each winter (Fitzner and Weiss 1994). Bald eagles have not nested along the Hanford Reach, although for the last several years unsuccessful nesting attempts have been documented. Access controls are in place along the river while eagles are present to prevent their disturbance. The DOE developed a site management plan (Fitzner and Weiss 1994) to mitigate eagle disturbance. This document constitutes a biological assessment for those activities implemented in accordance with the plan and, unless there are extenuating circumstances associated with a given project, the document fulfills the requirements of Section 7(a)(2) of the ESA for bald eagles and peregrine falcons. Section 7 (a) also requires consultation with the DOI when any action is taken that may destroy, adversely modify, or jeopardize the existence of bald eagle or other endangered species' critical habitat. At this time, bald eagles are under consideration for de-listing; however, the species will require five years of post de-listing monitoring (50 CFR 17).

Steelhead and salmon are regulated as Evolutionary Significant Units (ESU) by the NOAA-Fisheries based on their historical geographic spawning areas. The upper Columbia River ESU steelhead was listed as endangered in August 1997, and the Mid-Columbia ESU steelhead was listed as threatened on March 25, 1999. The upper Columbia River ESU spring-run Chinook salmon was listed as endangered in March 1999. These adult steelhead and Chinook salmon migrate upstream through the Hanford Reach to spawn in upriver tributaries, and juveniles pass through the Hanford Reach on their outward migration to the sea. A salmon and steelhead management plan (DOE 2000b) for Hanford Reach steelhead and upriver Columbia River ESU spring-run Chinook was developed as required by Section 7(a)(2) of the ESA.

Table 3.3. Federal or Washington State Threatened and Endangered Species on the Monument.

Common Name	Scientific Name	Federal[a]		State[a]
Plants				
Awned halfchaff sedge	*Lipocarpha aristulata*			T
Desert dodder	*Cuscuta denticulata*			T
Geyer's milkvetch	*Astragalus geyeri*			T
Scarlet ammannia	*Ammannia robusta*			T
Loeflingia	*Loeflingia squarrosa* var. *squarrosa*			T
Lowland toothcup	*Rotala ramosior*			T
Persistentsepal yellowcress	*Rorippa columbiae*	SC		E
Rosy calyptridium	*Calyptridium roseum*			T
Umtanum desert buckwheat	*Eriogonum codium*	C	E	
White Bluffs bladderpod	*Lesquerella tuplashensis*	C	T	
White eatonella	*Eatonella nivea*			T
Fish				
Bull trout	*Salvelinus confluentus*	T	C	
Spring-run Chinook	*Oncorhynchus tshawytscha*	E	C	
Steelhead	*Oncorhynchus mykiss*	E	C	
Birds				
American white pelican	*Pelecanus erythrorhychos*			E
Bald eagle[b]	*Haliaeetus leucocephalus*	T	T	
Ferruginous hawk	*Buteo regalis*	SC		T
Sandhill crane	*Grus canadensis*			E
Western sage grouse	*Centrocercus urophasianus phaios*	C	T	
Mammals				
Pygmy rabbit[c]	*Brachylagus idahoensis*	E	E	

Notes:

[a] E = Endangered (species in danger of extinction within all or a significant portion or its range).
T = Threatened (species likely to become endangered in the foreseeable future).
C = Candidate (species that are believed to qualify for threatened or endangered species status but for which listing proposals have not been prepared).
SC = Species of concern (species that are not currently listed or candidates under the ESA but are of conservation concern within specific FWS regions).

[b] Currently under review for change in status.

[c] Probably extirpated.

Although the current distribution of pygmy rabbit in Washington does not include the Hanford area, it has been reported as residing on the ALE (Fitzner and Gray 1991). However, this observation is based on only one reported sighting in 1979; this species has been searched for on the Hanford Site but has never been conclusively observed.

Table 3.4. Washington State Candidate and Sensitive Animal Species on the Monument.

Common Name	Scientific Name
Molluscs	
Giant Columbia River limpet (aka Shortface lanx)	*Fisherola* (*Lanx*) *nuttalli*
Giant Columbia River spire snail[a]	*Fluminicola* (*Lithoglyphus*) *columbiana*
Fish	
Bull trout[c,f]	*Salvelinus confluentus*
Mountain sucker[f]	*Catastomus platyrhynchus*
Leopard dace[f]	*Rhinichthys flacatus*
River lamprey[f]	*Lampetra ayresi*
Spring-run Chinook[b]	*Oncorhynchus tshawytscha*
Steelhead[b]	*Oncorhynchus mykiss*
Insects	
Columbia River tiger beetle	*Cicindela columbica*
Birds	
Burrowing owl[a]	*Athene cunicularia*
Common loon[g]	*Gavia immer*
Flammulated owl[f]	*Otus flammeolus*
Golden eagle	*Aquila chrysaetos*
Lewis' woodpecker[f]	*Melanerpes lewisii*
Loggerhead shrike[a]	*Lanius ludovicianus*
Peregrine falcon[a,g]	*Falco peregrinus*
Merlin	*Falco columbarius*
Northern goshawk[a,f]	*Accipter gentilis*
Sage sparrow	*Amphispiza belli*
Sage thrasher	*Oreoscoptes montanus*
Western grebe	*Aechmorus occidentalis*
Reptiles	
Sagebrush lizard[a]	*Sceloporus graciosus*
Striped whipsnake	*Masticophis taeniatus*
Mammals	
Black-tailed jackrabbit	*Lepus californicus*
Merriam's shrew	*Sorex merriami*
Townsend's ground squirrel	*Spermophilus townsendii*
Washington ground squirrel[d,f]	*Spermophilus washingtoni*
White-tailed jackrabbit	*Lepus townsendii*

Notes:

[a] Federal species of concern.
[b] Federal endangered.
[c] Federal threatened.
[d] Federal candidate for listing.
[e] Probable, but not observed, in the Monument.
[f] Reported, but seldom observed, in the Monument.
[g] State Sensitive (i.e., taxa vulnerable or declining) and could become endangered or threatened without active management or removal of threats.

Table 3.5. Washington State Plant Species of Concern on the Monument.

Common Name	Scientific Name	State Listing[a]
Annual paintbrush	*Castilleja exilis*	W
Annual sandwort	*Minuartia pusilla* var. *pusilla*	R1
Basalt milk-vetch	*Astragalus conjunctus* var. *rickardii*	W
Beaked spike-rush	*Eleocharis rostellata*	S
Bristly combseed	*Pectocarya setosa*	W
Canadian St. John's wort	*Hypericum majus*	S
Chaffweed	*Centunculus minimus*	R1
Columbia milkvetch	*Astragalus columbianus*	S[b]
Columbia River mugwort	*Artemesia lindleyana*	W
Coyote tobacco	*Nicotiana attenuata*	S
Crouching milkvetch	*Astragalus succumbens*	W
Desert evening-primrose	*Oenothera caespitosa* ssp. *caespitosa*	S
Dwarf evening primrose	*Camissonia* (‘ *Oenothera*) *pygmaea*	S
False pimpernel	*Lindernia dubia anagallidea*	W
Fuzzytongue penstemon	*Penstemon eriantherus whitedii*	S
Giant helleborine	*Epipactis gigantea*	W
Gray cryptantha	*Cryptantha leucophaea*	S[b]
Great Basin gilia	*Gilia leptomeria*	S
Hedge hog cactus	*Pediocactus simpsonii* var. *robustior*	R1
Hoover's desert parsley	*Lomatium tuberosum*	S[b]
Medic milkvetch	*Astragalus speirocarpus*	W
Desert cryptantha (miner's candle)	*Cryptantha scoparia*	S
Mousetail	*Myosurus clavicaulis*	S
Piper's daisy	*Erigeron piperianus*	S
Porcupine sedge	*Carex hystericina*	W
Robinson's onion	*Allium robinsonii*	W
Rosy balsamroot	*Balsamorhiza rosea*	W
Scilla onion	*Allium scilloides*	W
Shining flatsedge	*Cyperus bipartitus (rivularis)*	S
Small-flowered evening-primrose	*Camissonia* (‘ *Oenothera*) *minor*	S
Small-flowered nama	*Nama densum* var. *parviflorum*	W
Small-flowered hemicarpha	*Lipocarpha* (‘ *Hemicarpha*) *aristulata*	T
Smooth cliffbrake	*Pellaea glabella simplex*	T
Snake River cryptantha	*Cryptantha spiculifera* (‘ *C. interrupta*)	S
Southern mudwort	*Limosella acaulis*	W
Stalked-pod milkvetch	*Astragalus sclerocarpus*	W
Suksdorf's monkey flower	*Mimulus suksdorfii*	S
Thompson's sandwort	*Arenaria franklinii thompsonii*	R2
Winged combseed	*Pectocarya penicillata*	W

Notes:

[a] S = Sensitive (i.e., taxa vulnerable or declining) and could become endangered or threatened without active management or removal of threats.

R1 = Review List 1, taxa for which there are insufficient data available to support listing as threatened, endangered, or sensitive.

R2 = Review List 2, taxa with unresolved taxonomic questions.

W = Watch List, taxa that are more abundant and/or less threatened than previously assumed.

[b] FWS Columbia Basin federal species of concern.

Other federally listed species have been reported in very rare instances on or near the Hanford Site. The bull trout, a state candidate species and federal threatened species, has been reported in the Hanford Reach, but its natural habitat is mountain streams; anecdotal accounts of bull trout in the Hanford Reach are likely individuals moved downstream during the spring freshet. The Washington ground squirrel, listed as a candidate species by both the state and federal governments, was recently documented just north of the crest of the Saddle Mountains. Peregrine falcons are occasionally seen in the Hanford Site during migration but are no longer listed as a state or federal endangered species.

Washington State lists the American white pelican and sandhill crane as endangered and lists the ferruginous hawk, greater sage grouse, and bald eagle as threatened. Sage grouse were sighted on ALE in 1999 and 2000 but have been observed only once since then. Pelicans have become residents but are not known to nest here, and sandhill cranes have been occasionally observed in the Hanford Reach during spring migrations. Ferriginous hawks are known to nest and maintain breeding territories in several areas, including rock outcroppings, cliffs and metal transmission towers; the nesting population at Hanford represents roughly 20% to 25% of the breeding population in Washington State (Downs et al. 1993, Fitzner et al. 1994).

There are several Washington State candidate species that have been reported in the Hanford Site. Decline of shrub-steppe habitat statewide has resulted in the designation of black-tailed and white-tailed jackrabbits, Townsend's and Washington ground squirrels, and Merriam's shrew as state candidate species.

3.12 Special-Status Species and Communities

The Monument is home to many sensitive plant communities and species that are not officially listed by federal or state agencies as threatened or endangered but are of management concern within the state of Washington. This includes plant communities; rare plants, invertebrates, amphibians, reptiles, fish, birds and mammals; species new to science; and recreational/ commercially important species. Special-status species are species that are known to occur in the Monument, have historically occurred in the Monument, or have potential habitat that exists in the Monument.

3.12.1 Plant Communities

See also Section 3.9, "Plant Communities."

The Monument contains many endemic plant communities and species that have been lost or significantly reduced throughout all or a significant portion of their range. Map 15 shows approximate locations of sensitive plant communities and identified element occurrences in the Monument. Many plant communities have been ranked as either important locally, statewide or globally significant because of their rarity, or other factors making them very vulnerable to extirpation and extinction. Sensitive plant communities have been defined as those that are native plant communities within the Columbia Basin Ecoregion and have been identified as either state ranked, globally rare, or ecologically significant within western shrub-steppe environments; have significantly diminished throughout their range due to past and present management actions (grazing, agricultural development, urbanization, wildfire) and serve as important habitat for resident and migratory wildlife species; and could be significantly damaged or lost through major disturbances (i.e., wildfire) and require some additional protection considerations within the CCP. This loss would be significant within the context of regionally important plant communities for the longevity of wildlife species and potential reintroduction sites for listed species. Additionally, significant disturbance within these plant communities would lead to the rapid spread of non-native invasive species that would further threaten their ecological integrity and importance for effective wildlife habitat.

In 1994, TNC evaluated the ALE and Wahluke Units for each occurrence of a plant community type considered by the WNHP to be an "element" (i.e., a high-quality representative of a native plant community type) (TNC 1995). Each element was evaluated as to its condition, size and proximity to disturbance vectors such as roads, powerlines, off-road vehicle trails, or livestock grazing. Three factors formed the basis for the condition evaluation.

- The degree of invasion by non-native plant species.
- The composition of the community compared to descriptions by Daubenmire (1970), the WNHP, or other occurrences of the same element.
- The degree of soil disturbance and amount of microbiotic crust cover. TNC identified as potential element occurrences only those that met high-quality standards associated with the evaluation factors described above. The WNHP subsequently reviewed TNC evaluation results and made the final determination as to which occurrences qualified as element occurrences.

A total of forty-eight separate terrestrial plant communities, representing seventeen elements recognized by the WNHP, qualified as element occurrences. The seventeen elements constitute about 40% of all the terrestrial elements found in the Columbia Basin of Washington (WDNR 1995). Only three elements are common to both the ALE Unit and the Wahluke Unit. This indicates that to protect the full range of element diversity, both the ALE Unit and the Wahluke Unit must be considered. The element occurrences occupy about 45,170 acres of the ALE Unit and about 15,540 acres of the Wahluke Unit. The large sizes and excellent conditions of the big

sagebrush/bluebunch wheatgrass community (ALE Unit) and the bitterbrush/Indian ricegrass sand dune complex (Wahluke Unit) are especially noteworthy (TNC 1995).

TNC conducted additional fieldwork along the south shore of the Hanford Reach during 1995. As a result, six potential element occurrences of low elevation riparian wetlands were identified (Salstrom and Easterly 1995). The WNHP subsequently determined that all six qualified as element occurrences.

Table 3.6. Sensitive Plant Communities.

Species	Density Levels Recorded
Shrubs	
Stiff sagebrush (*Artemisia rigida*)	1,2,3
Big sagebrush (*Artemisia tridentata*)	1,2,3
Saltsage (*Atriplex nuttallii* var. *falcata*)	1
Grey rabbitbrush (*Chrysothamnus nauseosus*)	1,2
Green rabbitbrush (*Chrysothamnus viscidiflorus*)	1,2
Snow buckwheat (*Eriogonum niveum*)	1,2
Rock buckwheat (*Eriogonum sphaerocephalum*)	1,2,3
Winterfat (*Eurotia lanata*)	1,2,3
Spiny hopsage (*Grayia spinosa*)	1,2,3
Antelope bitterbrush (*Purshia tridentata*)	1,2,3
Grayball sage (*Salvia dorrii*)	1,2,3
Grasses	
Crested wheatgrass (*Agropyron cristatum*)	1,2,3
Cheatgrass (*Bromus tectorum*)	2,3
Prairie junegrass (*Koeleria cristata*)	1,2,3
Indian ricegrass (*Oryzopsis hymenoides*)	1,2,3
Bulbous bluegrass (*Poa bulbosa*)	2,3
Sandberg's bluegrass (*Poa secunda*)	2,3
Bluebunch wheatgrass (*Pseudoroegnaria spicata*)	1,2,3
Sand dropseed (*Sporobolus cryptandrus*)	1,2,3
Needle-and-thread grass (*Stipa comata*)	1,2,3
Forbs	
Carey's balsamroot (*Balsamorhiza careyana*)	2

Notes:

The densities recorded were: 1 = low cover (present to approximately 5%); 2 = irregular or clumpy, intermediate cover; and 3 = relatively even, moderate to dense cover. Where density levels of 3 were not recorded, levels 2 and 3 were not distinguished and cover greater than about 5% was recorded as level 2.

Poa secunda and *Bromus tectorum* are widespread in most of the drier cover types within shrub-steppe, with the latter particularly dominant on south-facing slopes. While attempts were made to indicate their relative distributions, in many (most) cases they varied on a fine scale. Extrapolations were therefore made from trends observed on the landscape, and accuracy will generally be greater on a landscape scale rather than at any one mapped polygon.

3.12.2 Plants

See also Section 3.9.4, "Rare Plants."

Table 3.5 lists Washington State plant species of concern that are currently listed as sensitive or are in one of three monitored groups (WNHP 2002). In addition to the eleven species that are identified as threatened or endangered in Washington State, thirty-two species of rare plants have been documented to be present in the Hanford Site (forty-three rare plant species total). These species are either Sensitive, Review Group 1, Review Group 2, or Watch List in the state of Washington (WNHP 1997). Four of these species are federally listed by the FWS as species of concern in the Columbia River Basin Ecoregion.

Map 15 shows the approximate locations of populations of the plant species of concern. The map is not intended to represent all areas where plant species of concern may be present; rather, the figure shows only general locations where the presence of individual plant subpopulations or populations have been documented. Even areas that have been surveyed potentially could contain other plant species of concern. For example, certain rare annual and/or early flowering plants that are sensitive to the drought conditions that were present during the early part of 1994 may have been missed during the TNC surveys (TNC 1995). Those areas searched by TNC during 1994, 1995 and 1997 are depicted in TNC (1995), Caplow and Beck (1996), and Hall (1998), respectively. These reports also can be referenced for more detail about specific species.

Plant species of concern are best protected by protecting locations in which they occur or could potentially occur. In large measure, this can be accomplished by protecting areas that contain intact native plant communities.

3.12.3 Invertebrates

See also Section 3.10.3.1, "Terrestrial Invertebrates."

A large effort to document and identify invertebrate biodiversity was conducted by TNC during a biodiversity inventory effort in 1995-1999. These surveys focused on terrestrial invertebrates, lepidoptera (butterflies and moths), and some aquatic invertebrates, including some molluscs. Insect diversity is high, with more than 1,500 taxa identified so far; the actual number of insect species occurring in the Hanford Site may reach as high as 15,500. A total of 1,509 species-level identifications were completed in 1999 and 500 more are expected. Recent surveys included the collection of 40,000 specimens and have resulted in the identification of 43 new taxa and 142 new findings in the state of Washington (Soll et al. 1999). The high diversity of insect species in the Hanford Site reflects the size, complexity and relatively undisturbed quality of the shrub-steppe habitat.

Umtanum Ridge and the shorelines of the Hanford Reach have been identified previously, because of their butterfly diversity, to be of particular importance for Washington butterfly conservation (Pyle 1989). Results from TNC surveys indicate Rattlesnake Ridge also supports a fauna, similar to Umtanum Ridge, of uncommon butterflies (TNC 1995).

Aquatic invertebrate species of concern are currently limited to those found in the Hanford Reach (Frest and Johannes 1993). (However, a spring area on Umtanum Ridge also contains an endemic land snail not known from any other location.) Detailed ecological and distributional information about the shortface lanx (*Fisherola nuttalli*) and Columbia pebblesnail (*Fluminicola columbiana*) in the Columbia River Basin can be found in Neitzel and Frest (1993). Frest and Johannes (1993) speculate that the relatively sparse nature of Hanford's mollusc fauna (both freshwater forms and land snails) is due to the presence of only a few streams in a large area that possess few continuous or seasonal connections. Moreover, they also speculate that human modification of the spring/stream systems during the early part of the twentieth century may have caused certain species to be extirpated from the Hanford Site.

3.12.4 Amphibians and Reptiles

See also Section 3.11.3.2, "Amphibians and Reptiles."

A TNC biodiversity inventory focused surveys to attempt to document the biodiversity of amphibians and reptiles on the Hanford Site (TNC 1999); this inventory is the most comprehensive account to date of herptofauna. Although distribution and abundance are not comprehensively recorded, relative abundance and habitat associations can be used to guide conservation and management of these species. Five species of concern occur in the Hanford Site (Table 3.3). All species can be found in the upland shrub-steppe habitat; however, Woodhouse's toad is generally found near water. The striped whipsnake (*Masticophis taeniatus*) is at the northern extent of its range; however, it has been recorded in the Vantage area (Nussbaum et al. 1983), on the Saddle Mountain Unit (Radke 1980), and in 1996, after a long period without observation, in the Monument west of State Route 24 (DOE 2001a).

3.12.5 Fish

See Section 3.11.1.5, "Fish."

3.12.6 Birds

See also Section 3.11.3.3, "Birds."

Thirty-eight bird species recorded during recent surveys, including eighteen known to breed on the Hanford Site, are considered species of conservation concern at a state or federal level, or are known or suspected to be declining. Several of these species are closely associated with sagebrush/grassland habitats. Further, many birds, especially migratory species, rely on riparian vegetation or other water based habitats for some or all of their lifecycle, which is disrupted by water fluctuations from upstream dams.

Appendix K provides information on the temporal occurrence of birds of conservation concern in the Monument. By knowing when species tend to arrive and leave the Monument, and when the sensitive periods of their life cycle (such as nesting) occur, activities can be better planned to avoid impacts on these species. Because most of the bird species that constitute the Monument's characteristic avifauna are migratory, direct impacts on these species potentially can occur away from the Monument (e.g., in wintering areas), as well as when they are here. Indirect impacts, however, such as losses of habitat, can occur at any time of year.

The Monument is recognized as an important area for maintaining viable populations of shrub-steppe-dependent birds within the Columbia Basin Ecoregion, especially for sagebrush obligate species such as the sage sparrow. Although specific sighting information is important to establish use of particular habitats by specific species, not all areas have been surveyed, and use can be dynamic. The approach taken in this management plan to address most avian species of concern is to identify the distribution and extent of the habitat most likely used by those species. Thus, conservation of most individual avian species of concern can be accomplished by conserving the habitats identified in Map 15, the Monument's habitats of concern.

3.12.7 Mammals

See also Section 3.11.3.4, "Mammals."

Forty-four species of mammals have been documented on the Hanford Site (TNC 1999; Fitzner and Gray 1991). Additional species have ranges that extend to the vicinity of the Hanford Site; therefore, it is possible that some of these species may be present in suitable habitat. At present, there are twelve mammal species of concern that are potentially found on or near the Hanford Site (Table 3.3). One species, Ord's kangaroo rat, though not yet documented in the Hanford Site, may be present, especially on the Wahluke Slope. The pygmy rabbit has not been observed on Hanford since the early 1980s and may be extirpated; although suitable habitat is present, recent searches for pygmy rabbits have not resulted in any positive indication that rabbits are present (Cadwell 1994; TNC 1997). The remainder of the species noted as special-status species all occur on the Hanford Site and are characteristic shrub-steppe species (Rickard et al. 1988).

3.12.8 Recreationally/Commercially Important Species

Species that are important culturally (either recreationally, commercially, or to Native Americans) are important from a resource management perspective. Table 3.7 provides a tentative list of recreationally/commercially important species for the Monument. The list is by no means complete and is intended to be dynamic. The table is composed mainly of species identified by the WDFW as important recreational and/or commercial species (WDFW 1996).

Table 3.7. Recreationally/Commercially Important Species On or Near the Monument.

Name	WDFW Priority Species[a]	Distribution and/or Habitat Association[b]	Abundance[b]
Birds			
Chukar (*Alectoris chukar*)	Yes (3)	Upper elevations	Abundant
Ring-necked pheasant (*Phasianus colchicus*)	Yes (3)	Riparian areas	Abundant
Gray partridge (*Perdix perdix*)	Yes (3)	Upper elevations	Common
California quail (*Callipepla califorica*)	Yes (3)	Upper elevations	Common
Mammals			
Rocky Mountain elk (*Cervus elaphus nelsoni*)	Yes (3)	ALE	Common
Rocky Mountain mule deer (*Odocoileus hemionus hemionus*)	Yes (3)	Entire site	Common
Fish			
White sturgeon (*Acipenser transmontanus*)	Yes (2,3)	Main channel/deep pools Columbia River	Abundant year-round
Channel catfish (*Ictalurus punctatus*)	Yes (3)	Slack areas near the upper portion of the McNary Pool	Common in spring and summer
Fall Chinook salmon (*Oncorhynchus tshawytscha*)	Yes (2,3)	Life-stage dependent; redds are located in the main channel of the Hanford Reach; juveniles use the whole Columbia River	Abundant
Coho salmon (*Oncorhynchus kisutch*)	Yes (2,3)	Main channel Columbia River	Uncommon
Rainbow trout/steelhead (*Oncorhynchus mykiss*)	Yes (3)	Main channel Columbia River	Abundant spring through fall
Sockeye salmon (*Oncorhynchus nerka*)	Yes (2,3)	Main channel Columbia River	Juveniles common spring and adults common summer
Largemouth bass (*Micropterus salmoides*)	Yes (3)	Sloughs of the Hanford Reach	Common
Smallmouth bass (*Micropterus dolomieui*)	Yes (3)	Sloughs of the Hanford Reach	Abundant
Walleye (*Stizostedion vitreum*)	Yes (3)	Main channel Columbia River	Common

Notes:

[a] WDFW (1996). See Section D.2.5.1 for definition of criteria.

[b] All habitat association, distribution, and abundance information for birds and mammals are from Fitzner and Gray (1991). Habitat association, distribution, and abundance information for fish were provided by Dennis Dauble (pers. comm. 1995) and were based on prior PNNL survey/scientific studies PNNL.

One species stands out as culturally significant: The fall Chinook salmon is of vital cultural importance to Native Americans, as well as of regional, national and international significance. Its cultural standing and regional/national/international significance make the fall Chinook salmon a species of management concern despite the fact the particular stock that uses the Hanford Reach to spawn is not listed as threatened or endangered. Historically, fall Chinook salmon spawned in the mainstem Columbia River from near The Dalles, Oregon, to the Pend Oreille River in Idaho; today the Hanford Reach is the only significant mainstem spawning habitat remaining for upriver bright stocks of fall Chinook salmon (Dauble and Watson 1990). The relative contribution of these upriver bright stocks to fall Chinook salmon runs in the Columbia River increased from about 24% of the total in the early 1980s to between 50% and 60% of the total in the 1990s; these stocks also have contributed to a higher percentage of the commercial, tribal and sport fishing catch since 1980 (Dauble and Watson 1990; NPS 1994).

3.13 Noxious and Invasive Species

Invasive alien plant species pose one of the most serious threats to the native biodiversity, wildlife habitat, and scenic values for which the Monument was created and for which the entire Hanford Site is well known. On the Monument, as elsewhere in western North America, invasive and noxious plant species compete against, and reduce habitat available for, rare plant taxa and native plant species. Weeds alter ecosystem structure and function, disrupt food chains and other ecosystem characteristics vital to wildlife (including rare and endangered species), and can dramatically alter key ecosystem processes such as hydrology, productivity, nutrient cycling, and fire regimes (Randall 2001, Brooks and Pyke 2001, Mack et al. 2000).

Thirty-six species of invasive weeds have been identified as target species for the Monument's weed management program (see Map 20). Twenty-three of these species have been documented as presently occurring in the Monument. Table 3.8 summarizes the noxious weeds that have been recorded to date on the Monument. In a large landscape with numerous target weed species, and where infestations vary from a single plant to hundreds of acres or more in size, a prioritization strategy for control and elimination of invasive plant species is essential to effectively allocate limited management resources.

The target list of invasive plant species for the Monument includes species that occur primarily in uplands, species that occur primarily in wetlands and riparian areas, and species of concern that are already widespread. Letter codes in the right-hand column of Table 3.8 indicate the weed's regulatory status in Washington State.

Table 3.8. Weed Species of Concern on the Monument.

Scientific Name	Common Name
Upland Species: Active List	
Acroptilon repens	Russian knapweed
Alhagi maurorum	Camelthorn
Bassia scoparia	Kochia
Cardaria draba	White top
Centaurea diffusa	Diffuse knapweed
Centaurea solstitialis	Yellow starthistle
Chondrilla juncea	Skeletonweed
Cirsium arvense	Canada thistle
Cirsium vulgare	Bull thistle
Convolvulus arvensis	Field bindweed
Gypsophila paniculata	Baby's breath
Lepidium latifolium	Perennial pepperweed
Linaria dalmatica	Dalmatian toadflax
Onopordum acanthium	Scotch thistle
Secale cereale	Winter rye
Sphaerophysa salsula	Swainsonpea
Tribulus terrestris	Puncturevine
Upland Species: Watch List	
Abutilon theophrasti	Velvetleaf
Anthriscus sylvestris	Wild chervil
Carduus nutans	Musk thistle
Cenchrus longispinus	Sandbur
Centaurea biebersteinii	Spotted knapweed
Euphorbia esula	Leafy spurge
Sorghum halepense	Johnsongrass
Taeniatherum caput-medusae	Medusahead wildrye
Wetland and Riparian Species: Active List	
Eleagnus angustifolia	Russian olive
Lythrum salicaria	Purple loosestrife
Myriophyllum spicatum	Eurasian watermilfoil
Phragmites australis	Common reed
Sonchus arvensis ssp. *arvensis*	Perennial sowthistle
Tamarix parviflora	Saltcedar, tamarisk
Tamarix ramosissima	Saltcedar, tamarisk
Wetland and Riparian Species: Watch List	
Amorpha fruticosa	Indigobush
Cyperus esculentus	Yellow nutsedge
Epilobium hirsutum	Hairy willow-herb
Myriophyllum aquaticum	Parrotfeather
Species of Concern Which Are Already Widely Established	
Upland	
Bromus tectorum	Cheatgrass, downy brome
Salsola tragus (aka *Salsola kali*)	Russian thistle, tumbleweed
Wetland and Riparian	
Phalaris arundinacea	Reed canarygrass

The FWS uses an integrated pest management approach to treat targeted invasive plant species in the Monument (see hanfordreach.fws.gov/documents/weeds.pdf for the draft IPSIMP).[69] Manual, mechanical, biological, cultural (e.g., prescribed fire, competitive plantings) and chemical treatment methods are used to achieve prioritized weed control objectives. Invasive species managers draw upon the full range of appropriate control technologies to develop integrated treatment plans for target species at selected sites. Treatment methodologies are based on the best information available from weed management literature and professional experience, tailored to the characteristics of the particular species and site.

3.14 Cultural Resources

The Monument Proclamation states:

> This magnificent area contains an irreplaceable natural and cultural legacy . . . one of the few remaining archaeologically rich areas in the western Columbia Plateau, containing well-preserved remnants of human history spanning more than 10,000 years.

The unique and fortuitous circumstances (establishment of the Hanford Nuclear Reservation during World War II) that preserved natural and cultural resources since 1943 also created a unique set of cultural resources with contextual integrity that may no longer exist anywhere else in the region. These remnants of past human culture and activity are invaluable and irreplaceable keys to former life ways and behavior patterns. Unfortunately, some of the resources, such as the historic town sites, homesteads and other structures, as well as Native American traditional use areas and aboriginal occupation areas, were destroyed before and during establishment and operation of the Hanford Nuclear Reservation. However, there is little doubt that without the inadvertent protection of the area through its restricted public use, many of these resources would have been damaged or obliterated.

Protection of these cultural resources—including tangible portions of sites such as artifacts, features, structures, natural resources and landscapes (e.g., traditional use and sacred areas), as well as oral and written records—is paramount to management of the Monument. In addition to the preservation of the physical geography, the Native American ethnology and oral traditions, and the Euro-American written and oral histories, are the threads that tie together the story of the cultural landscape. The opportunity to meld this interaction between the scientific data and the human story is a critical element to support the protection of the cultural resources

[69] The draft IPSIMP is available for public review and comment concurrent with the review of this draft CCP. All comments on the draft IPM should be noted as such when submitted. The comment deadline on the draft IPM is the same as that of the draft CCP. A copy of the draft IPM is available on the same CD as the draft CCP or at hanfordreach.fws.gov/ccp/ipm.pdf. Paper copies of the draft IPM are available upon request, 509-371-1801.

in the Monument. Inheriting this resource brings an obligation to the FWS not only to manage the Monument for the protection and preservation of these heritage resources but also to enhance their value through public education.

Since cultural resources encompass many elements, it is helpful to use temporal divisions to distinguish and categorize these resources. The occupation and utilization of this region can be divided into two phases: the Pre-contact Period, representing Native American aboriginal occupation prior to Euro-American influence, and the Post-contact Period with Euro-American development and occupation of the area. Here, Pre-contact Period cultural resources will encompass those resources associated with Native American groups prior to 1800, and the Post-contact Period will include those resources associated with Euro-Americans after the arrival of Lewis and Clark, as well as those of Native American groups during this time frame.

3.14.1 Pre-Contact Native American Traditions

The Monument lies within the Plateau Culture Area of northwestern North America, which encompasses the Mid-Columbia area and adjoining regions. It is geographically defined as the region lying between the Rocky Mountains to the east and the Cascade Mountains to the west. The northern boundary of the Plateau Area is established by the great bend of the Fraser River, while the southern boundary is somewhat ambiguously determined by the Blue Mountains. Before the arrival of Euro-Americans, the people collectively known as the Plateau Indians occupied portions of what is today eastern Washington and Oregon, northern Idaho, western Montana, and southern British Columbia (Ray 1936). Ethnic groups occupying the greatest amount of territory in the study area were the Columbia, Walula, Wanapum and Wauykma. Other peoples whose aboriginal territories were located in the Mid-Columbia region were the Nespelem, southern Okanogan, Sanpoil, Umatilla and Yakama (Ray 1936). Other groups known to have inhabited the region from time to time—principally for gathering, hunting or trading purposes—include the Cayuse, Chelan, Colville, Kittitas, Methow, Nez Perce, Palus, Wayampam, Wenatchi, Wishram and the Lower, Middle, and Upper Spokan.

The aboriginal groups inhabiting the Plateau are further defined by two major linguistic classifications—Sahaptin and Salish. Although a strict geographical division is not apparent between the peoples speaking these languages, generally Sahaptin speakers were located in the southern portion of the Columbia Basin, and Salish-speaking peoples occupied the northern part of the region. Sahaptin dialects included the Cayuse, Nez Perce, Umatilla, Walla Walla, Walula, Wanapum, Wauykma, Wayampam and Yakama. The only Salishan speakers who may have utilized portions of the Monument are bands currently within the Colville Tribe.

Of the extant Native American cultures that currently occupy and utilize the area, much of what is now the Monument represents only a portion of their extensive aboriginal homeland. These cultures represent millennia of use. The archaeological record within the Monument goes back

at least as far as 8,000 years. A recent find on the Hanford Site of an early projectile point type dating approximately 10,000 years suggests earlier sites may exist along former shorelines of the Columbia River (Marceau 2002). Previous archaeological excavations in the surrounding region—Lind Coulee, Sunset Creek, the Marmes Rock Shelter, and the controversial "Ancient One" find in Kennewick—suggest that people occupied the areas during early Paleo-Indian periods over 10,000 years ago (Ames et al. 1998).

As indicated, a number of Plateau groups lived in or at least utilized portions of the Monument and its environs. Research varies on precisely which groups lived where within the Monument. Even today, there is little consensus among Native Americans in the region as to exact boundaries of their aboriginal territory. Currently, there are four federally recognized tribes (and the Wanapum Band, which is not federally recognized) who have aboriginal and/or ceded lands within the Monument. Following is a brief description of the tribal reservations that comprise the various tribes and bands with historical connections to the Monument. None of these tribes' reservations are within the Monument, although the ceded lands of one or more groups may be.

3.14.1.1 Confederated Tribes of the Colville Reservation

The Colville Indian Reservation is located in north-central Washington in Okanogan and Ferry Counties. Its boundaries are defined by the Okanogan River on the west, the Columbia River and Grand Coulee Dam on the south, Franklin Roosevelt Lake on the east, and latitude North 48.50 on the north. The principal reservation towns are Nespelem and Inchelium. The Colville Reservation, the second reservation established in the Mid-Columbia region, was created April 19, 1872. The original reservation encompassed an area of 2,850,000 acres; however, the boundaries were altered on July 2, 1872, to the present reservation size of 1,011,455 acres.

The original bands living on the reservation at its inception were the Callispel (Pend d'Oreille), Coeur d'Alene, Colville, Lake, Methow, Okanogan, San Poil, and Spokane. At present, the groups living on the reservation are listed as Colville, Entiat, Lake, Methow, Moses (Columbia), Nespelem, Nez Perce, Okanogan, Palouse, San Poil, and Wenatchee.

3.14.1.2 Confederated Tribes of the Umatilla Indian Reservation

The area that was the homeland to these groups (Cayuse, Umatilla and Walla Walla) included areas along the Columbia River and Blue Mountains in southeast Washington and northeast Oregon, totaling approximately 4,012,800 acres. The 1855 Walla Walla Treaty reduced this to a reservation of approximately 245,699 acres in northeast Oregon near the present town of Pendleton. After the Allotment Act and other reductions, the reservation dwindled to about 92,273 acres (Ruby and Brown 1992).

3.14.1.3 Nez Perce Tribe

The aboriginal land of the Nez Perce covered a horizontal band of land along the Lower and Mid-Columbia River in Oregon and Washington and extended east through Idaho into Montana, a land base estimated at 13–15,000,000 acres. The Treaty of 1855 established 7,500,000 acres for a reservation for the Nez Perce near the juncture of the present states of Idaho, Oregon and Washington just south of Lewiston, Idaho. The subsequent Treaty of 1863, enacted after gold was found along rivers near Orofino and Pierce (Idaho) within the Nez Perce Reservation, reduced the size of the reservation to a tenth of its former size. By 1887, the Allotment Act removed an additional half million acres to leave the Tribe with its present 250,000-acre land base (Nez Perce Tribe 2003).

3.14.1.4 Wanapum

The Mid-Columbia River between Vantage upstream of Priest Rapids and the Snake River near Pasco is the homeland of the Wanapum, who are not a federally recognized tribe. Often they are referred to as a band of the Yakama Indian Nation. The Wanapum occupied thousands of acres in the Pre-contact Period until their lands were encroached upon by Euro-American settlement in the Post-contact Period. Because they did not enter into any treaties with the United States, they were not restricted to a reservation or allotted lands. Instead, they have a unique agreement with a local county government and the Grant County Public Utilities District (PUD)—the Wanapum retain forty acres of their aboriginal village of P'na (fish-weir) at Priest Rapids, as well as hunting and fishing rights within the Grant County Public Utilities District jurisdiction.

3.14.1.5 Yakama Indian Nation

The Yakama Indian Nation Reservation is located in south-central Washington south of the town of Yakima. The towns of Wappato and Toppenish are within the reservation. The reservation is bounded on the west by the Cascade Mountains, on the northeast by the Columbia River, and on the southeast by the Horse Heaven Hills. The Treaty of 1855, one of the first in Washington, created the reservation. The Yakama Nation is comprised of fourteen bands whose aboriginal territory encompassed approximately 10,800,000 acres in the Columbia Basin and surrounding territory (Pace 1977). Today the reservation encompasses about 1,367,455 acres (U.S. Dept of Commerce 1974).

3.14.1.6 Ethnographic Background

The Plateau groups shared similar traits and cultural patterns of behavior in the occupation and use of the upland and riverine habitats in which they lived; a generalized ethnographic model is applicable to all of these inhabitants during the Pre-contact Period.[70] A brief overview of the cultural elements attributed to the groups in the Monument vicinity is presented here; further details can be found in the literature cited.

While the Monument seems a harsh environment, the area was surprisingly productive for those who knew how to use it. The cultural manifestation of the Monument environment in the Pre-contact Period revolved around adaptation to the extensive riverine and adjacent upland resources. Ancestors of the present day Colville, Nez Perce, Umatilla, Wanapum and Yakama Tribes fished for salmon; hunted deer, elk, sheep and rabbit; and collected and gathered roots, seeds and berries (Relander 1956).

Natural resources, including foods, medicines and material for tools and shelters, were gathered in the appropriate season, primarily spring to fall. The reliance on a seasonal harvest of primary subsistence items, such as anadromous fish and native root crops, promoted a non-sedentary, nomadic, non-agricultural economy. Specific environmental niches were occupied at various seasons in the process of collecting these resources. These food collection strategies also resulted in the establishment of a certain settlement pattern across the landscape, which repeated itself over thousands of year as indicated in part through the archaeological record. In general, the subsistence activities of these Sahaptins were very similar, as reflected in their economies, methods of resource procurement and processing, and the nature of habitation sites (Galm et al. 1985).

The year was compartmentalized and noted by the activities necessary to obtain fresh items to consume, as well as process and preserve the foods necessary to survive the remainder of the year. The harvest seasons corresponded to the maturation cycle of the foods, as opposed to particular months of the year. Temporary or seasonal camps, from which to base harvesting activities, would be established in the locale containing the resource. Although some camps, such as fishing sites, were located along the rivers, the majority of sites tended to be non-riverine and located in the uplands. The length of stay at a campsite was dependent on the duration and availability of the particular resource. People lived at various temporary campsites until they had collected a year's supply of food and other resources, and then they returned to the villages along the major rivers, where they spent the winter months.

The type of shelter used at seasonal residences was the conical mat house, which was a tipi-like formation of poles covered with layers of tule mats. It was generally erected on the ground

[70] Early ethnographers (Ray 1936; Spier 1936 and Kroeber 1939) believed these Plateau groups were all Sahaptin language speakers.

surface rather than within an excavated pit. The conical mat house was a more mobile form of the semi-subterranean lodge. It could be set up and dismantled in a relatively short time and its parts moved when the camp moved. The temporary nature of the conical mat house facilitated the high degree of mobility required by aboriginal peoples to efficiently procure widely distributed resources. These camps could be in place a few days to a few weeks, depending on the nature of the resource. For salmon runs, the fishing stations could be considered a repeated, seasonal encampment with a predictable and consistent resource, but plant resources required both differing locations and relocating camps. In addition to moving camps up in elevation as the crops ripened, rainfall, temperature and soils would determine the crop harvesting locale from year to year.

The time of year in which camps were occupied was correlated with the time the resources were in season. A variety of environmental zones were frequented for such activities. Yearly food procurement and other economic activities commenced in early spring for the first green shoots and edible roots, usually found in the foothills and upland plateau. In late February, preparations were made for travel from the villages to the locations of spring camps, and by early spring, the villages were generally deserted when people merged into groups of four or five families and traveled to those areas where the first vegetable foods were obtained.

Roots were the most important vegetable food in the aboriginal diet, and in some cases they comprised as much as 40% of the food intake (Galm 1985). Some families may have collected up to 1,500 pounds of roots in a season (Hunn 1990). One of the most sought after roots for Native Americans living around the Monument were of the genus *Lomatium*, the common names being cous, desert parsley, Indian celery, and biscuitroot. It still plays an integral part not only in the diet, but also in spiritual renewal and life-sustaining renewal traditions. Other important food roots were/are bitterroot, balsam root (mostly eaten as tender shoots), wild onion (eaten as a bulb), and yellow bell (bulb). The importance of digging roots is emphasized by the distance some groups traveled to obtain them (Hunn and French 1981).

Use and preparation of the roots varied, with some eaten fresh while others were dried or steamed for long-term storage. While the plants were young and tender, they were consumed raw or boiled. Bitterroot was commonly cooked, thickened with sugar, and made into a pudding. Practically all roots were processed for storage; they were frozen, hung on strings, placed on screens and sun dried, or baked for several days in an earth oven. After processing, they were eaten dried or baked, ground into flour and made into cakes, or reconstituted by boiling. During the aboriginal period, after an abundant supply of roots and other vegetal resources had been processed, they were transported to the sites of winter villages, stored in caches that had been excavated in the ground, and used throughout the winter months until fresh foods could be obtained the next spring. Contemporary processing of root plants is much the same as in the aboriginal and historic periods.

Data from interviews conducted with a number of Native Americans show that traditional root digging grounds are still utilized within the Mid-Columbia area and in other regions throughout

the Columbia Basin (Galm et al. 1985). Prominent ridges, such as Rattlesnake Mountain and the Saddle Mountains, are known as traditional spring root gathering areas. Sometimes root digging areas are so exclusive that they are recognized as belonging to individual families. This concept appears to exemplify a conscious effort to manage and conserve such areas by ensuring that they are not over-utilized from year to year. The roots may not be the staple they were in aboriginal times, but they still form a major part of the traditional first foods or root ceremonies to ensure bountiful harvests and ecological balance and renewal.

Root digging was followed by the first salmon runs in the spring. Fishing could occur year-round, but the harvesting seasons to catch, process and store food were associated with specific migratory runs. The Columbia River system supported a host of anadromous (mainly salmon) and other fish, including sturgeon, northern pike minnow, lamprey, various suckers, and several trout species.

The Mid-Columbia area contained several fishing locales, primarily associated with small rapids, such as Coyote Rapids, and islands, such as Locke Island. However, major fishing destinations, such as Priest Rapids and Horn Rapids on the Yakima River, lie just beyond the Monument. The most notable fisheries for the entire northwest were located downstream on the lower Columbia at Celilo Falls and The Dalles. No doubt, Native American groups from the area traveled to all of these locations, either to fish or trade with other groups in the region. Traditional courtesy gave preference to "family" ties with aboriginal fishing stations, much the same as with root digging lands. These major fishing sites were visited by both northern and southern Plateau groups, including the Columbia, Nez Perce, Palus, Spokan, Walula and Yakima (Chalfant 1974). On the Monument, the Wanapum had several fishing stations and camps; elders from the Wanapum and other groups have echoed the stories of traditional, favored fishing grounds.[71]

The fishing location determined the methodology for fishing, with apparatus varying from spears to nets. Pronged spears were utilized by individual fisherman, who generally speared the fish from the riverbanks or from large boulders in the water. In addition, canoes were employed, usually at night with torches, where fish rising to the light were speared from the bow. Even within historic times, the Wanapum used canoes for fishing; the canoe currently housed at the Wanapum Dam Visitor Center Museum may be one observed and photographed in 1941 near White Bluffs. Residents of the White Bluffs town site in the 1920s and 1930s recall trading tires

[71] The importance of fish to the Indians of the Mid-Columbia region, and the patterns of acquiring such resources, have undergone considerable change since aboriginal times. From the historic period to the present, salmon resources have been the source of a great deal of controversy and the subject of many management decisions with regard to Columbia River waters. Today, most traditional fisheries on the Columbia River and its tributaries have been greatly reduced by contemporary use and development of the rivers, such as the construction of dams. Fishing sites and areas that were once the habitats for salmon and other fish, such as falls and rapids, have been inundated, and higher water temperatures and over-fishing have reduced the numbers of fish. Thus, rivers that were once abundant with salmon now support relatively small populations. At present, most of the salmon fishing is done on the lower Columbia River.

to the Wanapum for fish, as the Indians would burn chunks of rubber attached to poles on the bow of the canoe as torches for nighttime fishing (W. Grisham personal communication). Traps and weirs were often placed near the mouths or confluences of smaller streams and rivers; areas where the water was not moving swiftly tended to be desirable. Dip-netting from platforms was done near falls and rapids. Nets or seines made of native hemp fitted with stone net sinkers were used in deeper waters. Nets could also be drifted between the noses of two canoes.

The late summer/early fall harvests focused on seed and berry collecting and hunting of game animals, primarily in the uplands. These activities were typically gender specific, with men hunting and women collecting. Most of the animals taken served both as food and other products such as tools, clothing and utensils. Big game species included mule deer, white-tailed deer, elk, antelope and bighorn sheep. Waterfowl and upland birds taken were ducks, geese, sage hen and grouse. Collecting berries was a fall activity accomplished by women and often children. Berries were obtained from relatively high elevations in the forested areas of the Cascade Mountains, Okanogan Highlands, Selkirk Mountains, and other mountainous regions. Typical species harvested included chokecherry, elderberry, huckleberry, soapberry, serviceberry, thimbleberry and wild currant. Many of these are still collected by Native Americans in the region.[72]

Of particular note, tule was harvested at this point in the year. Tule grows in muddy or marshy areas along potholes, streams and rivers in the Columbia Basin. It is generally harvested in the late summer before the frost, then bundled and dried for future use in the weaving of bags and mats. Aboriginally, tule mats were used in the construction of shelters, including the conical mat tipi and the winter long house. The plant has a slender round stem which grows approximately four feet high; the stems are generally laid side by side and sewn together using a greasewood or metal needle and tule or jute string at each end, forming a mat approximately four feet wide and as long as needed. Present locations for collecting tule include several wetland areas, such as the McNary Wildlife Refuge, areas just west and north of Richland, the Soap Lake region, and just off the Monument on Crab Creek.

After the fall salmon runs and berry picking were complete, all food provisions and other transportable resources were carried back to the main village for the winter. Winter encampments were typically located in the lower elevations, often along major rivers or at the confluences with tributaries, for protection from the elements as well as access to resources such as firewood, fresh aquatic foods and water. The stored foods prepared throughout the year provided sustenance for individual families, but the community-based residential pattern also

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[72] Other resources important to Native Americans were harvested either throughout the year, or at specific times, according to need or availability. Many of these materials are still harvested. For example, Indian hemp is a native plant that is found in riverine settings along the Columbia River. The branches are cut in the fall, bundled and dried. To make hemp string, the stem is split to expose an inner fiber that is stripped out and worked with a stone tool or knife; the fibers are then rubbed back and forth between the palm of the hand and the thigh to merge and strengthen the fiber. The twine was utilized in making fishing and hunting nets, ropes and root or other food storage bags.

provided security for the population because any surplus or even "whatever you had," was shared with others. Winter months were spent rejuvenating, both in the physical and spiritual sense, to prepare for the rebirth of the next year. Tools were formed or re-sharpened, nets were mended, baskets and clothing were made as necessary. Stories and oral histories were passed on, and social activities and food surplus sharing took place both intra-village and sometimes inter-village.

Early explorers and later ethnographers described several villages within the Monument. The fifty-mile stretch of the Hanford Reach contains numerous village sites, primarily attributed to the Wanapum. Some have been recorded both in early historical records as well as archaeologically. These villages, comprised of oval or circular housepits, were established along the river terraces and islands. They housed the main population concentrations, with extended family groupings in mat lodges, a community long house, and a sweathouse.

The semi-subterranean lodge, referred to as a pit house in archaeological terms, consisted of an excavated pit approximately ten to sixteen feet in diameter and four to six feet deep with a conical or flat roof. The roof was made from planks or mats made of willow branches or tules. The conical-shaped roof tended to be the one most used among Columbia Basin Indians (Ray 1939). A fire hearth was constructed in the center of the lodge and a small smoke hole left in the roof. The semi-subterranean lodge accommodated a single or an extended family. The mat long lodge was a rectangular tent-like structure. It was built upon a foundation of slanted poles tied together in pairs at the tops, forming an inverted V-shape. Additional poles were attached at the sides and then were covered with several layers of tule mats. Sometimes larger versions of these, known as *long houses*, were built to accommodate large gatherings of people for social activities such as ceremonials and council meetings (Teit 1930).[73] Other kinds of religious activities, including dances, curing rites, winter festivals, and funerals, were often conducted at the sites of winter villages. Today, these ceremonies are often held in modern long houses.

Another structure often associated with the winter village was the sweathouse. Basically, these were modified forms of other house types, incorporating similar principles of construction and the same materials (Ray 1933). The sweathouse was generally constructed on the edge of a stream or river, as after steaming for several minutes the bather would plunge into a pool of cool water. The function of the sweathouse—spiritual purification, physical cleansing, curing, and socializing—was closely intertwined with Indian beliefs and was an important aspect of the aboriginal culture. Even today, the sweathouse is an important component of Native American culture and is utilized by a number of Salish and Sahaptin peoples for traditional purposes (Turner et al. 1975 and 1980; Walker 1966).

Apart from an abundance and variety of natural resources, the Mid-Columbia also offered another advantage to Native Americans—its centralized location along several rivers. Most of

[73] The use of the long house is prevalent on reservations today throughout the Plateau.

the vast, semi-desert region east to the Columbia was traveled and utilized for several major economic subsistence functions by most, if not all, of its tribal groups living on its periphery (Chalfant 1974). Trading networks between tribes allowed a wider exchange of non-local goods and provided interaction among people. Being in the Mid-Columbia provided an advantage for local groups to network with others to obtain desired commodities such as shell from the coast, obsidian from Idaho and Oregon, and buffalo from the Plains.

3.14.2 Post-Contact, Euro-American Traditions

The early exploration of the area began with the fur trappers in the early 19th century, shortly after Lewis and Clark ventured through the confluence of the Columbia and Snake Rivers just south of the Monument in 1804. David Thompson of the Northwest Company is the first documented explorer to pass through the Hanford Reach in 1811 on his way down the Columbia River in search of furs and trading possibilities. Other fortune seekers soon followed.

The discovery of gold in Idaho and Canada in the 1860s expanded the use of the Mid-Columbia and heralded beginnings of permanent development. The White Bluffs Road, likely first an Indian trail, became part of a travel system linking the river and the Caribou Trail on the north side of the Saddle Mountains. A small, transitory community emerged on the east bank of the river at the White Bluffs Road ferry crossing, which began operation in 1859. White Bluffs became a bustling supply depot for unloading goods shipped by river onto wagons for overland distribution to gold discoveries in British Columbia, Idaho and Montana. Gold fever struck the local region as well with activity along the Ringold, Vernita and other river shorelines. By the 1870s, Chinese miners were also working the placer gravels (Sharpe 1999). As the need for supplies—especially food—grew, agriculture and stock-raising activities increased. Permanent settlement commenced in the late 1880s and 90s with scattered homesteads near water sources, primarily the river. The native bunchgrass steppe, mild winters, and open range provided a perfect environment for grazing, which attracted cattleman from other areas.

The Columbia River was a driving force for development. From the time the first explorers passed through the area, the river was the logical transportation corridor and remained the avenue to transport goods and people for nearly a century until the railroads arrived. The river was the key to settlement, providing transportation via steam-driven freighters and numerous ferries to the settlements of Wahluke, Vernita, Richmond, White Bluffs, Hanford and Ringold (Ruby and Brown 1974). More importantly, water for crops was critical, so irrigation companies formed. The development of several irrigation and land companies, supported in part by outside capital, provided the impetus to true settlement and town sites development. By 1907 the most significant irrigation development in the Hanford Reach, the Hanford Irrigation and Land Company, began construction of a major, twelve-mile ditch from the Allard Pumping Station near Coyote Rapids to the Hanford and White Bluffs communities (Parker 1986).

The anticipation of profits provided incentives for Seattle-area developers to invest in the area. The success of the venture brought the first significant regional recognition to this unknown area, based primarily on the area's mild climate, readily available and level land, perfect growing conditions for early crops, and irrigation. Orchards replaced other crops and livestock as the profitable commodity. The marketing of the new real estate and fruit crops resulted in railroad connections by 1913 with a spur line to Hanford from the Chicago, Milwaukie and St. Paul Railroad, which provided the link for shipping products to coastal markets. The rail lines also benefitted farmers through quicker receipt of supplies and equipment. Ironically, the rail lines resulting from irrigation changed the Columbia River's role as a transportation corridor; by the 1920s, steam freighters had nearly vanished from the river.

For over two decades, the towns of Hanford and White Bluffs grew and prospered. The White Bluffs area was selected as a soldiers' home location after WWI; many of these ex-soldiers provided labor to established farmers (Parker 1986). Advertisement through the realty companies and railroad land agents attracted nearly 500 families, many fleeing the Midwest in the 1920s and 30s looking for new starts. The Depression years reduced prosperity as a result of lower crop values, but many families could at least continue their own existence through subsistence farming and local economic systems. The First National Bank of White Bluffs remained open, and presumably solvent, throughout the lean years, not closing until 1942 (Harris 1972).

In 1943 these towns and the entire area changed forever. The Manhattan Project, designed to build the atomic bombs of WWII, required removal of all residents of White Bluffs and Hanford. Although some of the buildings became offices and residences for a short time, most were eventually removed along with crops, orchards and landscaping.

3.14.3 Cultural Resources Inventory in the Monument

The Monument contains some of the most diverse and extensive cultural resource areas remaining in the Mid-Columbia Plateau. The current inventory of these resources is based on a summary of archaeological, historical and ethnographic data collected from archival records, archaeological surveys, and personal communication. It does not reflect a complete inventory, as only 24% of the Hanford Site, including the Monument, has been surveyed for archeological resources (Neitzel 2005). The percentage of lands surveyed within the Monument portions of the Hanford Site is substantially lower; it is estimated that less than 5% of the total Monument has been surveyed. However, the amount of land surveyed varies by unit. The shoreline of the River Corridor Unit has been surveyed several times due to being the focus of DOE projects along the river shore as well as projects by other agencies. A DOE survey of 3,473 acres along the shoreline included a 0.25-mile strip of the eastern boundary of the over 6,000-acre dune field that is part of the River Corridor Unit (Hale 1999).

The DOE reports that 1,447 cultural resource sites and isolated finds, and 530 historic buildings and structures, have been documented on the Hanford Site (Neitzel 2005). Of these documented sites, 575 sites lie within Monument boundaries, with just over half (367) in the River Corridor Unit. Current project work has identified an additional 70 sites within the Monument, bringing the total to 645 sites in the Monument. The Hanford Site cultural resource site totals are directly related to the amount of DOE project work in each unit, as well as the size of the unit. Each management unit has the following number of sites: Columbia River Unit, 367 sites; Rattlesnake Unit, 221 sites; Saddle Mountain Unit, 23 sites; and Wahluke Unit, 32 sites (eight in the proposed Ringold Unit). Site records reflect various levels and styles of reporting, so the database is marginal at best. Comparative analysis, or even accurate site location and description, is sketchy. The bulk of the sites are pre-contact related. Only 127 sites have been evaluated for listing in the National Register; 49 have been listed. Except for the B-Reactor, which is associated with the Manhattan Project and Cold War Period, the other listed sites are associated with the Native American use and occupation. Most of the National Register sites are part of seven National Register Archaeological Districts, all of which fall in the Monument, including the Ryegrass, Hanford North, Locke Island, Savage Island, Snively Canyon, Rattlesnake Springs, and Wooded Island Districts. With the exception of the Rattlesnake Springs and Snively Canyon Districts, all are situated on the shores and islands of the Columbia River. At least a portion, if not all, of these districts fall within the Monument. In addition, two archaeological districts within the Monument—Wahluke and Coyote Rapids—are listed on the Washington Heritage Register.

3.14.3.1 Pre-Contact Archaeological Investigations

Nch'i-Wana (the Wanapum word for "big river") for thousands of years was the lifeblood of the Native Americans in the region (Hunn 1990). Without the Columbia River, survival in the harsh desert environs of the Columbia Basin would have been difficult. The Columbia River provided, and still provides, water, fish, shellfish and numerous other resources to Native American peoples. As a result, the river shores have a high density of pre-contact sites; the Hanford Reach has numerous seasonal camps, resource processing areas, and village sites (Swindell 1942).[74] This density of sites along the river and their accessibility has enticed archaeologists and collectors to the area for the past 80–100 years; the Smithsonian excavated sites in the Wahluke in 1926 (Krieger 1928). Consequently, the Hanford Reach has been studied, or at least explored, for as long or longer than any other area in the Northwest.

This extensive use and occupation of the Monument area for thousands of years has left a cultural record with both an extensive and well-preserved diversity of archaeological resources prior to Euro-American contact. However, documentation of these resources is spotty. The majority of the field work that has been undertaken in the area, primarily along the river, is the

[74] In addition, several traditional cultural properties and sacred areas are known to exist in the Monument.

result of government projects such as ACOE dam proposals, Hanford Site development, or clean-up activities. Information is project-specific and often remains incomplete or unpublished. In addition, a few scattered university projects and field school excavations have been done but again often remain unpublished. Little fieldwork has been accomplished in the outer reaches of the Monument, and virtually none of it has been done systematically or with a specific research design. The result is that knowledge is limited for many areas and/or is disconnected.

The documented cultural chronology of the Monument, based on archaeological site information, spans the past 8,000 to10,000 years. This is not to say that earlier sites do not exist. Some of the particular types of artifacts found in the Monument area and the surrounding region represent styles (especially of projectile points) that date from as early as 14,000 ago or more. However, archaeological investigations have been limited, based primarily on large hydroelectric and transmission line project studies in the 1960s and 1970s that were focused along the river corridors. Hence, regional synopses of Plateau cultural traits have been derived principally from survey and excavations within or adjacent to the Snake and Columbia River drainage system. The reasons for this were twofold: 1) riverine terrace sites and associated rock shelters were easily accessed and often contained the extensive and deeply stratified sites necessary for the development of regional cultural chronologies; and 2) most archaeological research in the Columbia Plateau prior to 1970 was conducted to salvage archaeological materials before the river valleys were inundated by water backing up behind hydroelectric dams. (Refer to Rice 1980; Galm et al.1981; Ames et al. 1998; and Aikens 1993 for details.)

Table 3.9. Archaeological Time Periods.

Chronological Sequence for the Mid-Columbia Basin			
Time Period	***Climate***	***Phase Names***	***Cultural Attributes***
Late Period 4500–250 B.P.	Increased moisture initially then drying. Current climate regime by about 1,500 B.P.	Frenchman Springs Cayuse Tucannon Harder	Bow and arrow; groundstone; small-sided, basal and corner-notched points; net weights; seasonal use of areas, especially riverine areas; food storage; pit house villages; introduction of historic (contact) material by end of period.
Middle Period 8000–4500 B.P.	Gradual warming and drying, then cooler.	Cold Springs Cascade Vantage	Leaf-shaped and large side-notched spear points, bifaces, cobble and flake tools, plant material for cordage for bags and nets, bone, antler and groundstone tools, seasonal gathering using temporary base camps for processing resources. Both rockshelters and open camps for other occupation areas.
Early Period 14000–000 B.P.	Cool and wet.	Clovis Windust Lind Coulee	Large stemmed, fluted and leaf-shaped spear points, bifaces, flake and cobble tools, bone and antler tools, diverse collection of plants, hunting and fishing with occupation in open and cave sites.

Several models have been used to explain cultural dynamics within this region. Although some of the regions for which this cultural history was developed are peripheral to the Monument, extensive excavations of riverine sites have provided the broad comparative database for the analysis of such sites in similar environs within the Monument. Table 3.9 provides a broad overview of the cultural chronology of the area. Here, the chronology of the pre-contact resources are divided into three phases—Early Period, Middle Period, and Late Period.

3.14.3.1.1 Early Period (14,000–8,000 Years Before Present)

The Early Period is often also referred to in the literature as the Paleo-Indian Period. The early part of this time frame is poorly represented in the Plateau region, with only a scattering of stratified sites with early occupation components and isolated projectile points. A geological time marker in the area frequently utilized in soil profiles is Glacier Peak ash from a volcanic eruption approximately 13,700 years ago. Unfortunately, evidence of the ash, which appears in some locations within the Monument, is rarely associated with cultural material.

The predominant artifacts are lanceolate projectile point forms used on throwing and thrusting spears. Other artifact types include large, bifacially flaked knives or point preforms, scraping tools of various kinds, gravers for working bone, and cylindrical foreshafts of bone (Chatters 1989). Regionally defined artifact types include leaf-shaped and stemmed varieties of points known as Windust and early Cascade Forms. Fluted Clovis Points (circa 12,000–10,800 Before Present [B.P.]), noted to the northwest of the Monument from the renowned Clovis cache at the East Wenatchee site, have not been found in the Monument. A single report of a Clovis-style point was reported by a local collector near Kennewick (Chatters 1989).

In the Windust Phase, 10,500–8,000 B.P., sites are generally small and exhibit low artifact densities. Tools found in sites from this period include leaf-shaped and stemmed projectile points, bifaces (knives), hammerstones, cobble and flake tools, net weights, cores, ocher, and bone and antler tools. Windust-style points have been found in the Monument along the Columbia—one on the surface near the Vernita Bridge (Hazelbrook 2000), one on an island within the Hanford Reach (Woody 2003), and another at excavations in central Hanford near the 100K Reactor (Sharpe and Marceau 2001). Groundstone tools, such as mortars and pestles and cobble chopping tools, became more prevalent toward the mid to late Early Period, suggesting plant or possibly mammal bone processing.

3.14.3.1.2 Middle Period (8,000–4,500 B.P.)

This time frame, often correlated to the term Archaic Period, is most noted and recognized throughout the region by the trademark artifact known as the Cascade Point. The other hallmark of the time was the eruption of Mt. Mazama (forming Crater Lake) near the beginning of this

period, about 6,700 years ago. Researchers in the mid-Columbia area often refer to this period as the Vantage Phase based on Nelson's (1969) work on Sunset Creek. It overlaps somewhat with the Early Period in this scheme and is the earliest phase (9,500–6,500 B.P.) described for the Mid-Columbia region. Diagnostic artifacts of this phase include leaf-shaped, stemmed and side-notched projectile points, hammer stones, edge-ground cobbles, core tools, and bifaces.

During the Cascade Phase, inhabitants were highly mobile, opportunistic foragers adapted mainly to riverine environments with an increased reliance on fish and less use of game (Chatters 1986; Galm et al. 1985). Middle Period sites appear primarily on river terraces within the Monument, although two Cascade-style points are noted from sites on the northern plain of Rattlesnake Mountain.

3.14.3.1.3 Late Period (4,500–250 B.P.)

The Late Period is the last record of Native American cultures prior to contact with explorers, trappers, miners and settlers. The first half of this period is basically an extension of the Middle Period, reflecting the continued use of atlatls for upland game hunting. Point styles include large, side-notched, lanceolate and triangular-shaped points with concave and expanding bases. Groundstone, bone and antler tools round out the lithic tool kit that contains bifaces, adzes, drills and other tools. Other stone and bone tools remain much the same as in the Middle Period, with the addition of the hopper mortar and an increase in bone needles and single-piece and composite harpoons. Early phases include type sites at two springs: the Cold Springs Phase and the Frenchman Springs Phase.

A major technological innovation in weaponry marks the latter half of this period with the appearance of the bow and arrow about 2,500 B.P. This is a distinctive feature with a substantial reduction in point size in the latter half of the Late Period under phase names such as Cayuse and Harder. Such points are distinguished by features such as side notches, ears, tangs and bases to facilitate hafting to arrow shafts.

This phase is also noted for the introduction of semi-subterranean, bermed pit houses and more specialized camps for hunting, root collecting, and plant processing. Populations concentrated in large, nucleated winter villages, some with fifty or more pit houses. Winter villages consisted of long, tule mat community lodges, surrounded by individual and extended family pit houses. Pit house villages are typically located in riverine settings, primarily at the confluences of major drainages, on low-lying terraces, or on larger islands within the channels. People dispersed to gather roots in the spring and to hunt in the fall and winter. This seasonal round became increasingly diverse and well-organized over time. Temporary camps were associated with seasonal procurement strategies from spring to fall. There was increased utilization of salmon, shellfish, and root crops and other plant materials in this period.

This time is probably the best represented period within the Monument. Pit house complexes are numerous on both side of the river and on several islands, although many date to the later stages of the Late Period. These pit houses are often relatively intact, with obvious surface depressions representing the living floor in more protected, undeveloped areas. Short-term, seasonally used sites do not have pit houses, but contain artifacts similar to long-term use sites (Greene 1975). The distinction between the two types of sites rests primarily with the presence or absence of pit houses and the density of artifacts, with winter sites tending to accumulate more debris. Rice (1980) reported that 53% of the recorded archaeological sites along the Hanford Reach were open camps, 26% were fishing stations, and 14% were open camps with pit houses. These findings reveal that seasonal use of the area centered on the fall fish migrations and winter villages.

3.14.4 Pre-Contact Resources

No synthesis of the Mid-Columbia archaeological record has been developed, so the exact numbers of sites within the Monument is based on DOE and Washington State Historic Preservation Office (SHPO) databases. As noted previously, much of the existing data is based on cultural resource compliance work for government agencies, including project work undertaken by the DOE since 1987, through consultants, universities and tribal cultural resource programs. Consequently, the work undertaken has been primarily within Central Hanford, not on the buffer lands (i.e., the Monument) where few projects occurred. In addition, the Mid-Columbia Archaeological Society (MCAS), a vocational group active between 1968 and 1978, conducted surveys and excavations along the river, contributing some additional information.

In contrast to other areas of the Columbia drainage, the Hanford Reach has had few major data recovery excavations. The entire Hanford Site has only had sixteen sites excavated (Marceau and Sharpe 2002). Most of these, including projects of the MCAS, were excavated thirty to forty years ago. Some of these excavations constitute minimal test excavations. Report detail for all of the work by various parties in the area varies; some surveys and excavations remain unreported, some are incomplete. Little systematic survey or excavation addressing research questions or theoretical considerations has been undertaken in the Hanford Reach. A recent notable exception is the excavation of two small seasonal camps within the Monument on the south shore of the river (Marceau and Sharpe 2002). The sites represent early spring shellfish gathering and small-to-medium game hunting/processing camps used over the past 3,000 years.

In general, recorded archaeological sites on the Hanford Reach tend to be on the alluvial flats and lower terraces near the shorelines and islands of the Columbia River. Due to the unique geomorphology of the area, there are no known rock shelters or mesa top sites, which are

typically found both upriver and down river from the Hanford Site.[75] Upland sites have been discovered on Gable Butte (Central Hanford), Rattlesnake Mountain, and near the few isolated springs such as Rattlesnake and Snively on the Monument.

The archaeological record indicates that the south bank of the Columbia River contains greater concentrations of sites than the north bank.[76] The geography of the area may be the primary determinant as the northern bank of the Columbia River is dominated by the vertically imposing White Bluffs, with over 200 feet of vertical rise directly from the river. As a result, fewer terraces and suitable village areas exist on the north side in comparison to the south side. The south bank also contains greater numbers of ephemeral drainage channels with more food resources and desirable areas for storage, shelter, water and travel (Marceau 2002). The south bank is logistically closer to a more diverse supply of upland resources. Water may also have been a consideration for the upland sites; upland sites on the south side of the Columbia River contain more inland springs and ephemeral streams than the upland areas that are located north of the river.

The majority of the total site inventory represents a wide range of Native American site types, including pit house villages, campsites, fishing stations, root gathering and resource processing camps, caches, hunting blinds, rock cairns, talus pits, hearth features, sacred locations, cemeteries, quarries and lithic tool production sites. Resource procurement and processing sites make up the bulk of the sites, but a large number of isolated artifacts are also included.[77] Many of these isolated artifacts, especially those located along the river, may be part of larger sites but have not yet been incorporated into a specific site assemblage. The riverine sites include nineteen of the twenty-three pit house sites recorded and all of the fish processing stations. One of these sites contains a concentration of over fifty pit house depressions, one of the largest such villages remaining in the region. The number of pit house depressions visible on the ground surface is substantially higher in the Hanford Reach than other parts of the Columbia, likely as a result of its remoteness, direct preservation due to the access restrictions in place since 1943, and the lack of agriculture and development along the shoreline.

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[75] No such sites have been recorded, although a few isolated areas of exposed basalt have the potential to yield these types of sites.

[76] The south bank or shore is frequently called the west bank due to bends in the river. Likewise, the north bank or shore is frequently considered the east bank.

[77] Lithic materials and minerals were important resources and were utilized during the aboriginal period as medicines, paints, cleaners and stone tools. Tools, such as projectile points, knives and scrapers, were generally manufactured out of fine-grained materials, including obsidian, cryptocrystalline silicate (chert and chalcedony), and petrified wood. However, Native Americans report that the only raw material collected from the Mid-Columbia region was chert (flint). Yakama peoples contend that they obtained this material in the Saddle Mountains, and there appear to be major lithic material quarries found during an archaeological survey of the Saddle Mountains region.

Limited archaeological excavation has occurred outside of the river corridor, and radiocarbon dating of the sites that have been studied tends to cluster in the later periods covering the past 3,000 years. This correlates with the more intensive riverine use associated with salmon fishing that was common through out the region during this time period.[78] It is likely that numerous earlier sites do exist but have not been located yet. They are likely associated with higher elevation spring areas and possibly rock shelters within the ridge systems and older terraces along the ancestral meander channels of the Columbia. Much of this topography lies either in Central Hanford, away from project work which centers near the reactors, or within the buffer zones now within the Monument.

Another type of cultural site that may be found in the Monument is a TCP. In 1990, the NPS formalized the concept of TCPs as a means to identify and protect cultural landscapes, places and objects that have special cultural significance to Native Americans and other ethnic groups. A TCP eligible for the National Register is associated with "cultural practices or beliefs of a living community that are rooted in that community's history and are important in maintaining the continuing cultural identity of the community" (Parker and King 1990). Due to their sacred nature, many traditional cultural places remain unidentified. No specific TCPs have been recorded in the Monument, but certain landforms, especially Rattlesnake Mountain and the Saddle Mountains, as well as certain sites or features along and including the Columbia River, remain sacred to various tribal entities and may represent TCPs.

3.14.5 Post-Contact Resources

Approximately 650 historic archaeological sites associated with Euro-American settlement—including an assortment of communities, farmsteads, irrigation features, mining features, roads, ferries and debris scatters—have been recorded on the Hanford Site. However, this is a fraction of the potential number of sites that may have existed. Few structures associated with Euro-American settlement remain in the Monument due to Manhattan Project/Cold War operations. Due to security and other reasons, many structures were razed from 1943 into the 1970s. Of those that remain, only a few are within the Monument. The known structures in the Monument consist of the Allard Pumphouse, Hanford Irrigation and Power Station, BPA Midway Substation, Bruggeman Fruit Warehouse, White Bluffs log cabin, and a stone structure near the Midway Substation.

Little remains of many structures, and much of what is left is threatened. The White Bluffs cabin, built in 1894 and potentially eligible for the National Register, was stabilized in 2001 to avoid potential collapse; vandals had removed a wall log causing the sod roof to sag. Of the historic communities and homesteads, a few structural features, such as foundations, irrigation ditches/canals, cisterns, landscape plantings, roadbeds and ferry landings, are all that remain to

[78] It is unclear why salmon fishing became more intensive at this point in history.

define the site. Several of those sites known in the Monument include the Wahluke, Allard, McGee, Cold Springs, Midway, Hanford and East White Bluffs settlements. The latter towns retain some platted streets, and Hanford's main street is within the Monument. Numerous farms and ranches, such as Snively, Bennett, Benson, Borden, Foster, Coonce, Splawn, Perkins, Young and Thumb, and Wiehl, existed prior to 1943, and various elements remain. However, no structures exist for any of these homesteads, primarily due to removal during use of the Hanford Site. Many of these homesteaders or their ancestors are integrally connected with the history and development of the region. Few of the structures have been evaluated for the National Register.

Artifacts and sites from the Manhattan Project and Cold War era are much better preserved; the landscape comprises cultural resources associated with plutonium production, military operations, research and development, waste management, and environmental monitoring activities that took place, beginning with the establishment of the Hanford Site in 1943 through the end of the Cold War. In 2002, the DOE released a major study of the built environment on the Hanford Site. The study was undertaken to assess the National Register significance of the remaining buildings and features to determine which ones to preserve as site cleanup progresses. A total of 530 structures and building complexes have been determined eligible for the National Register (DOE 2002).[79]

Military operations in various forms took place on the Hanford Site from WWII to the early 1960s. Evidence of resources associated with military operations, including foxholes, roads, graffiti and debris scatters, is mainly archaeological in nature. Historic military sites are scattered mostly in Central Hanford, but also include several anti-aircraft artillery sites within the Monument and three Nike missile installations on Wahluke Slope and one at the base of Rattlesnake Mountain on the ALE. The anti-aircraft artillery and Nike sites were strategic components in defense of the Hanford Site's plutonium production facilities during the 1950s and early 1960s. The Nike position on the ALE has been determined eligible for inclusion in the National Register as a contributing property within the Hanford Site Manhattan Project and Cold War Era Historic District (DOE 2002). Potential archeological resources at these sites include former gun emplacements, launch and radar sites, concrete foundations and pads, pathways/sidewalks, debris scatters, small arms firing ranges, and ammunition caches.

[79] On March 1, 2006, the NPS initiated a study of the B Reactor and its associated Chemical Separations Building (T-Plant) to determine their eligibility and suitability for—and the feasibility of—addition to the National Park System. The Hanford Site is being studied along with sites in Oak Ridge, Tennessee; Dayton, Ohio; and Los Alamos, New Mexico.

3.15 Tribal Uses

The historic uses of the Monument by Native Americans are described in great detail in Section 3.14.1, "Pre-Contact Native American Traditions," Section 3.14.4, "Pre-Contact Archeological Investigations," and Section 3.14.5, "Pre-Contact Resources." Many of these uses continue on to this day and into the future. At present, tribal use of the Monument is limited and involves only a few activities, in part due to past closures by the DOE and concerns over contaminants. Current use primarily focuses on the gathering of medicinal and food plants, while certain areas of the Monument are also used for spiritual and ceremonial practices. It is likely that other tribal uses will be reestablished in the future as contaminant concerns are addressed, treaty issues are resolved, and resource protection plans are developed and implemented.

The FWS recognizes past and ongoing tribal activities, and through this CCP and subsequent step-down plans will work to address long-term stewardship issues for the protection of cultural resources and traditions and the enhancement of natural resources vital to the continuance of tribal uses. The existing FWS Native American Policy, stemming from Executive Order 13175, assists the FWS in accomplishing this mission of resource protection while also guiding the federal government's interactions with tribes. The FWS will:

> . . . assist Native Americans in protecting, conserving and utilizing their reserved guaranteed, or statutorily identified trust assets . . . The Service will consult with Native American governments on fish and wildlife resource matters of mutual interest and concern to the extent allowed by law. The goal is to keep Native American governments involved in such matters from initiation to completion of related Service activities.
>
> The FWS will provide Native Americans with reasonable access to FWS-managed or controlled lands and waters for exercising ceremonial, medicinal, and traditional activities recognized by the FWS and by Native American governments. The FWS will permit these uses if the activities are consistent with treaties, judicial mandates, or federal and tribal law and are compatible with the purposes for which the lands are managed.

As noted repeatedly, this CCP does not define or delineate treaty rights, trust resources, valid existing rights, and so on. Those issues are best left to other planning processes, government-to-government negotiations, and the development of agreements between the FWS and tribes. What is relevant for this CCP is that the FWS will honor those rights and work with the tribes to develop the appropriate access plan.

3.16 Visual/Aesthetic Resources

The Monument is a land of stark beauty. To visitors from more temperate climates, the Monument can seem quite barren, and it is often only through time that this perception is changed. Once the visitor learns what is hidden in the Monument and what it takes to survive in this arid land, the Monument comes alive, and the appeal of the Columbia Plateau's shrub-steppe becomes manifest.

There are many things to catch the eye in the Monument, including the topography of the landscape. On one side of the Monument, Rattlesnake Mountain rises almost 3,600 feet above sea level; on the other side, the Saddle Mountains rise to 2,181 feet in the Monument. Wahatis Peak, although on BLM lands, reaches 2,621 feet above sea level and is visible from the Monument. In between, Gable Mountain and Gable Butte rise into the sky in Central Hanford. Large rolling hills are located to the west and far north. The 200-foot White Bluffs, steep whitish-brown bluffs adjacent to the Columbia River and above the northern boundary of the river, are a strong feature of the landscape. Elsewhere, berg mounds, arroyos, and sand dunes provide additional relief to the landscape.

The view toward Rattlesnake Mountain is visually pleasing, especially in the springtime when wildflowers are in bloom. The Columbia River, flowing across the northern part of the Hanford Site and forming part of the eastern boundary, is generally considered scenic, with its contrasting blue against a background of brown basaltic rocks and sagebrush.

In the sections that follow, visual intrusions in the Monument will be cataloged. In reading through these sections, it would seem the Monument's aesthetic resources have been severely affected by previous action. In some instances, this is indeed true. However, it is important to remember that the Monument covers almost 200,000 acres and has a varied terrain. Standing on a knoll, the visitor may be able to see facilities in Central Hanford, the steam plume from Energy Northwest's nuclear power plant, transmission lines, irrigation canals, and other man-made influences. Moving 100 yards, though, may drop the visitor into canyons where no readily apparent human impacts mar the scenery. Mule deer, coyotes, and songbirds of all descriptions complete the appearance of a natural landscape. The Monument is a land of contrast between the natural world and that of human creation. While the following sections mainly highlight the human-related modifications in the Monument, the Monument provides an equal opportunity to escape from these intrusions.

3.16.1 Columbia Plateau Aesthetic/Visual Characteristics

As previously noted, the Monument is located in the center of the Columbia Plateau Physiographic Province in semi-arid south-central Washington State. Topographic features have

a direct influence on the aesthetic/visual character of the Monument and the surrounding region. Major features—such as river valleys, rolling uplands, ice age features, and the Columbia River—give form to the Plateau. In addition to topography, vegetation patterns and land uses have an influence on the region's aesthetic/visual character. Pre-settlement vegetation communities in the semi-arid Plateau were composed of an assortment of plant communities that were generally dominated by various combinations of sagebrushes and grasses, collectively known as shrub-steppe. Other habitat types (such as riparian) are also present and have an influence on aesthetic/visual character, but are less prevalent than shrub-steppe. Past land uses have changed the distribution of the shrub-steppe habitat type and have had a strong influence on the aesthetic/visual character. These land uses (including agriculture, military, conservation, residential, research, and energy production and transmission) have resulted in removing or altering shrub-steppe habitat and, in some cases, introducing new vegetation types. Intact areas of shrub-steppe habitat type are generally in undeveloped and/or protected areas of the region, such as the Monument. Some of these areas retain pre-settlement aesthetic/visual character. Some new land uses have introduced new features into the landscape such as buildings, highways, dams, and cleared areas that have influenced the region's aesthetic/visual character.

3.16.2 Monument Aesthetic/Visual Characteristics

The Monument and adjacent lands contain a number of features that influence the aesthetic/ visual character of the Monument. The following discusses the existing aesthetic/visual character of the Monument.

In describing the Monument, the use of the proposed new management units is a far better way to describe the landscape than through the use of the existing management units, unlike the description of the affected environment to this point. The main reason for this is that the lands within the proposed management units are more similar in character and use than that found under the current situation. As such, the following subsections are organized by the proposed management units. Elements within each unit that influence the unit's aesthetic/visual character are briefly described, including topography, vegetation, land use, land management, and cultural modifications. To describe specific views from within each unit, key observation points (KOPs) were selected from around the Monument.[80]

[80] An extensive visual resources/aesthetics assessment was completed to assist in preparation of this EIS. The full visual resources report includes panoramic photographs, a brief description of uses near the KOP, visual features and visible alternations to the landscape that can be seen from the KOP, viewers, and viewer sensitivity.

3.16.2.1 Ringold Unit

3.16.2.1.1 Topography

The Ringold Unit is located in the eastern part of the Monument. The unit is bordered by the Columbia River to the southwest and steep weathered bluffs to the north. The approximately twelve-square-mile Hanford Dune Field is across the Columbia River from the Ringold Unit (part of the Columbia River Unit). The dunes are a very prominent topographic feature that can be seen from the southern parts of the Ringold Unit.

3.16.2.1.2 Vegetation

Vegetation in this unit has been heavily affected by historic uses, such as homesteading and farming. More contemporary uses and events such as grazing, irrigation, planting non-native vegetation for wildlife benefits, and fire have also affected the unit's vegetation patterns and appearance. There are remnant areas of shrub-steppe vegetation along with areas of riparian vegetation, but human activities and the extensive presence of non–native invasive species have resulted in a vegetation pattern that, from a biological perspective, is among the most disturbed in the Monument. From an aesthetic/visual perspective, some of the vegetation in the Ringold Unit has obviously been altered (primarily in the southern part of the unit), yet some areas have a relatively intact appearance (primarily in the north part of the unit and along the Columbia River and a major drainage ditch).

3.16.2.1.3 Land Use/Management

The Ringold Unit is managed to provide wildlife, fisheries and recreational benefits. As mentioned previously, past uses have resulted in changes to original (predominantly shrub-steppe) vegetation patterns, which has influenced the aesthetic/visual character of the unit. Fisheries management objectives resulted in the construction of the Ringold Fish Hatchery complex by the WDFW, which has a direct influence on the aesthetic/visual character of the part of the unit from which it can be seen. The complex is located immediately south of the unit and is the most visually prominent feature in the areas from where it can be viewed. In addition to wildlife and fisheries, recreation is a significant activity. Because the unit is accessible by road, is close to the Tri-Cities, has a history of being open to the general public, and can accommodate a number of recreational activities, it is a popular recreational area, and the majority of people who visit are involved in recreational activities. Recreational facilities include dirt or gravel parking areas and a primitive boat launch near Parking Lot 7. A heavily used cobblestone boat launch and an undefined/informal campground (miscellaneous campsites, ad hoc dirt roads, and fire rings) just south of the unit is on land managed by the WDFW.

Lands outside of the Monument to the east are irrigated croplands and have an agricultural character that contrasts with the scrub-shrub vegetation found in the unit. Most of the lands west of the unit across the Columbia River are included in Central Hanford, except for the area that contains the Hanford Dune Field (which is located in the Columbia River Corridor Unit). The Energy Northwest Columbia Generating Station is located approximately three miles south of the unit and can be seen from many locations within the unit, particularly during times of the year when the steam plume is visible due to atmospheric conditions.

3.16.2.1.4 Cultural Modifications

The primary cultural modifications visible to the general public are the Ringold Fish Hatchery and the informal campground, which are located outside of Monument, and two residences near the entrance to the Monument. A dirt road running the length of the unit and several associated parking lots are also significant cultural modifications. The SCBID has irrigation canals that are visible within and near the unit. Next to one of the canals is an emergency notification siren mounted on a tower that is quite visible from Ringold Road. The agricultural lands, the Energy Northwest facility mentioned previously, and the Energy Northwest Pumphouse (particularly visible at night due to security lights) are cultural modifications outside of the Monument that can be seen from parts of the Ringold Unit.

3.16.2.2 Wahluke Unit

3.16.2.2.1 Topography

There are several visually prominent topographic features seen from within and/or near the Wahluke Unit. The most visually prominent feature is the Wahluke Slope that lies to the north and east of the unit. The Wahluke Slope is an expansive south-facing slope that drops from the top of the Saddle Mountains to the edge of the Columbia River. The unit also contains dune fields, Saddle Mountain Lake, and a series of other lakes approximately twelve miles east of Saddle Mountain Lake that are known as the Wahluke Lakes and/or the WB-10 Ponds.

3.16.2.2.2 Vegetation

Shrub-steppe and riparian vegetation communities dominate the landscape in the Wahluke Unit and greatly influence its aesthetic/visual character. The unit contains extensive areas of big sagebrush mixed with needle-and-thread grass, Sandberg's bluegrass, and cheatgrass. Riparian areas are found in the vicinity of the Saddle Mountain Lake, the Wahluke Lakes, and scattered wetlands. The unit includes several low-lying areas near Saddle Mountain and Wahluke Lakes

that contain wetlands and are interesting aesthetic/visual features that contrast with the adjacent dry shrub-scrub vegetation.

3.16.2.2.3 Land Use/Management

The western part of the Wahluke Unit is part of the existing Saddle Mountain National Wildlife Refuge and is managed for wildlife and research purposes. Public access is restricted and limited primarily to research and educational activities. The eastern part of the unit is managed for multiple resource objectives. This part of the Wahluke Unit contains important migratory bird habitat and waterfowl breeding areas, along with other valuable habitat. In addition to having significant natural resource values, the eastern portion of the Wahluke Unit is also an important recreational resource. Because so much of the eastern part of the unit is open to the public and contains a road system, it offers perhaps the greatest access (and viewing) opportunities to the general public in the Monument. Recreational activities that attract visitors and viewers to the Wahluke Unit include hunting, fishing, hiking, wildlife observation, and photography.

The most visible land uses on lands outside the Monument that can be seen from the Wahluke Unit occur in Central Hanford, primarily the 100 Area facilities along the south side of the Columbia River.

3.16.2.2.4 Cultural Modifications

Cultural modifications that are visible to the general public include transmission lines that pass from south to north across the unit into the Saddle Mountain Management Unit, an abandoned railroad grade, several borrow pits, gravel storage areas near State Route 24, unpaved roads (including the remains of the historic White Bluffs Road), SCBID canals, and several unpaved parking areas. The most visible cultural modifications outside of the Monument are those associated with Central Hanford operations; the facilities that can be seen from various parts of the Wahluke Unit to the south and west include the 100B/C, 100K, 100N, 100H and 100F facilities.

3.16.2.3 Saddle Mountain Unit

3.16.2.3.1 Topography

The most prominent visual topographic feature here are the namesake Saddle Mountains. From the southern boundary of the Saddle Mountain Unit (State Route 24), the terrain slopes steadily

upward at a fairly gentle rate to the toe of the southern face of the Saddle Mountains. From this point, the terrain rises steeply approximately 400 to 500 feet to the crest. Several high points along the crest that are within the unit reach elevations of over 2,000 feet. Wahatis Peak, approximately one mile northeast of the Saddle Mountain Unit's boundary, reaches an elevation of approximately 2,700 feet and is a very noticeable topographic feature.

3.16.2.3.2 Vegetation

Vegetation is varied and includes extensive areas of big sagebrush mixed with rock buckwheat/bunchgrass and Sandberg's bluegrass/cheatgrass associations. Irrigated orchards can be seen outside the Monument to the north and northeast. They contrast sharply with the dry shrub-steppe vegetation of the unit (and nearby undeveloped areas outside of the Monument).

3.16.2.3.3 Land Use/Management

The Saddle Mountain Unit is managed primarily for wildlife resources, although recreational use is also allowed. As with the eastern portion of the Wahluke Unit, the Saddle Mountain Unit can be accessed by the general public for day-use recreational activities such as hunting, horseback riding, and hiking; however, there are no developed recreational facilities in the unit.

3.16.2.3.4 Cultural Modifications

Cultural modifications within the Saddle Mountain Unit that are visible to the general public are limited and include scattered borrow pits, roads, the White Bluffs Wasteway (irrigation water return), spoil banks, and the Wahluke Branch irrigation canal. Transmission lines that pass from south to north through the unit are quite visible. The most visually prominent cultural modifications occur on top of the Saddle Mountains and include the foundations of Nike missile installations and roads leading to the installations. A number of Central Hanford facilities are visible in the distance to the south beyond the unit's boundaries.

3.16.2.4 Columbia River Corridor Unit

3.16.2.4.1 Topography

This unit follows the Hanford Reach of the Columbia River for over forty miles. The terrain adjacent to the Columbia River Corridor Unit varies from steep bluffs on the east and north sides of the river, to flatter areas on the west and south sides. The White Bluffs, located in the central

part of the unit, is perhaps the most dramatic area topographically within the Monument. Other aesthetically/visually prominent topographic features in the unit include the Hanford Dune Fields, a number of low-lying islands, side channels, and drainage canals that enter the river.

3.16.2.4.2 Vegetation

There is a wide variety of vegetation types within the Columbia River Corridor Unit. Riparian vegetation along the river is one of the primary characteristics of the unit; areas that support riparian vegetation include islands, low-lying areas along the river, side channels, and areas where canals enter the river. Most of the vegetation types found in the various units of the Monument can be found somewhere within the Columbia River Corridor Unit. In addition to native vegetation types, trees remaining from old farms and town sites can be viewed at various locations along the river, as can relatively recently planted rows of poplars for agricultural wind breaks on bluffs above the river.

3.16.2.4.3 Land Use/Management

As the last free-flowing reach of the Columbia River in the United States, the Hanford Reach is an important recreation resource. Many people viewing this area do so from motorized or non-motorized boats. The majority of motorized boaters access the river from one of the boat launches within or immediately adjacent to the Monument, while non-motorized boaters generally put in at Vernita Bridge and take out at the White Bluffs Boat Launch or the Ringold Fish Hatchery. These access points are important viewing sites, as recreational users spend extended time launching and trailering their boats at these locations.

Land uses outside of the Monument that are visible from within the unit include those associated with Central Hanford on much of the southern and western sides of the unit (primarily the 100 Areas and Energy Northwest facilities) and agricultural uses along parts of the southeastern portions of the unit. Electrical transmission lines pass through the unit and are visible throughout.

3.16.2.4.4 Cultural Modifications

There are relatively few cultural modifications directly in the unit. The modifications that do occur include transmission lines that cross the river, the three boat launch facilities mentioned previously and their associated access roads/parking areas, the White Bluffs log cabin, and the White Bluffs Ferry Landing. The Vernita Bridge at the north end of the unit is a prominent visual element, as are numerous transmission lines within and outside the Monument. A number of other visually prominent modifications can be seen that are outside the Monument. The

Energy Northwest pumphouse is visible on the west bank of the river, particularly at night when security lights are visible. Other modifications are in Central Hanford and include both facilities that are adjacent to the river and facilities located away from the river but visible from it. Some of the visible structures have been "cocooned," and others appear to be largely intact, although not in use.[81] The N Reactor facilities are prominent features located on the banks of the river and are the most visually dominant cultural feature that can be seen from the river. Other facilities associated with Central Hanford can be viewed from various stretches of the river.

3.16.2.5 Rattlesnake Unit

3.16.2.5.1 Topography

The most visually dominant topographic feature here is Rattlesnake Mountain, which is located along the southwestern edge of the unit. The axis of the approximately five-mile long Rattlesnake Mountain runs from southeast to northwest and rises approximately 3,000 feet from the toe of the mountain to the crest (with elevations of over 3,450 feet). The slopes of Rattlesnake Mountain are as steep as 60% and have been incised by numerous watercourses that seasonally flow into Dry Creek or Cold Creek. Although there are no permanent streams in the Rattlesnake Unit, there are several permanent, or near permanent, springs (Rattlesnake, Benson, and Snively Springs) located below Rattlesnake Mountain. West of Rattlesnake Mountain at the southwest corner of the unit are the Rattlesnake Hills. North of the Rattlesnake Hills, the eastern end of the Yakima Ridge enters the unit and is visible from State Routes 240 and 243. Most of the topography found at the lower elevations of the Rattlesnake Unit is gently rolling or relatively flat. The north edge of the unit is located several miles east of the State Route 240/State Route 24 junction and overlooks the Columbia River Valley.

3.16.2.5.2 Vegetation

Rattlesnake Mountain is reputedly the highest "treeless" mountain in the continental United States. Many of the slopes on the mountain are covered in grasses, with scattered areas of sagebrush along the mountaintop. Until a major wildfire in 2000, the unit contained one of the largest remaining areas of undisturbed shrub-steppe vegetative community in the State of

[81] 'Cocooning' is term used to describe part of the cleanup of nuclear reactors along the Columbia River. The outer shell (building) around the reactors is removed, leaving just the 'hot' reactor core. A secure, weather-proof, 'cocoon' is then constructed around the remaining reactor core, which will remain in place for several decades as the reactor core cools. At some point in the future—an estimated 70-80 years—the DOE will determine the appropriate manner in which to handle the then-cooled reactor core. Unfortunately, the finish used on the cocoons to date is of a highly reflective material and can be seen for extensive distances.

Washington. In addition to areas along the mountaintop (which contains three-tip sagebrush), the other parts of the unit that contained significant areas of sagebrush (big sagebrush) are those on either side of State Route 24. As a result of the fire and historic grazing practices, many areas of sagebrush have been replaced by extensive areas of cheatgrass and other invasive species. These areas are what people looking at Rattlesnake Mountain from State Route 240 and points north and east of the mountain see as "grasslands" and give Rattlesnake Mountain much of its character. There are isolated areas of riparian vegetation near the springs mentioned previously. These relatively lush, isolated riparian areas contrast greatly with the nearby dry shrub-steppe vegetation but are not seen by the general public. Three abandoned fields located in the Snively Basin still contain large areas of grass, dominated by black rye planted in approximately 1940. However, these areas are not publicly accessible and thus are not seen by the general public.

3.16.2.5.3 Land Use/Management

Part of the Rattlesnake Unit—the ALE on the east—is an RNA managed to protect and conduct research on the natural systems found within the Monument. The western end of the unit was a buffer for the Hanford Site. The entire unit has restricted access, and as such, recreation and other types of visitation and use are limited. As a result of these policies, public opportunities to view the Rattlesnake Unit from within have been limited in frequency and location. Public access to the unit is limited to educational and research-oriented activities.

Adjacent to the Monument along the south side of State Route 240 is a proposed DOE borrow area; while this site is not yet disturbed by construction, the development and operation of the borrow area may impact the visual character of the Rattlesnake Unit. This area may be disturbed by haul road construction before this draft EIS is issued. Lands west and south of the unit visible from the top of Rattlesnake Mountain are mostly private and used for cattle grazing or field crop production.

3.16.2.5.4 Cultural Modifications

The most visible cultural modifications in the Rattlesnake Unit that can be seen by the general public are transmission lines and roads. BPA transmission lines (and unpaved access roads) cross from east to west through the southern and northern parts of the unit. There are a number of unpaved roads, some of which are visible from State Route 240 and the top of Rattlesnake Mountain. From the top of the mountain, the observatory and commercial telecommunications facilities, such as antennae and satellite dishes, are prominent visual features.

From State Route 24, Central Hanford has an undeveloped character, although roads and security features (fences, stations) can be seen. However, Central Hanford facilities are readily visible from Rattlesnake Mountain. The agricultural lands west and south of the unit, visible from

Rattlesnake Mountain, used for cattle grazing have a somewhat natural appearance, whereas areas used for crop production have an agricultural character.

Some of the research conducted on or near the Rattlesnake Unit is world-renowned. For example, at the base of Rattlesnake Mountain is a gravitational research lab operated by researchers from the University of California at Irvine and the PNNL of Richland. The facility is located in a decommissioned Nike missile installation; also near the decommissioned Nike site is a fire staging area and storage facilities for the FWS. Just off the Monument, but readily visible from Rattlesnake Mountain, is the Laser Interferometer Gravitational Wave Observatory, which uses two aboveground, mile-long tunnels to measure gravitational events in deep space. While certainly unique, components of the Rattlesnake Unit, these facilities, and other research sites and equipment, affect the visual character of the unit.

Other cultural modifications located in the unit that are not visible to the general public include landfills, additional unpaved roads, gas wells, test wells, foundations and other features from homesteads, the decommissioned Nike missile site, and an abandoned rail line.

3.16.2.6 Central Hanford

Although not a part of the Monument, Cental Hanford greatly influences the visual character of many parts of the Monument. The 280-square-mile area contains a number of visually prominent natural and culturally modified features, some of which can be seen from the Monument and some of which cannot. The following briefly highlights some of the more prominent features that can be seen from the Monument. These features have been categorized as Natural Features and Cultural Modifications.

3.16.2.6.1 Natural Features

The two most visually prominent natural features in Central Hanford are Gable Mountain and Gable Butte. Gable Mountain is an approximately five-mile-long outcropping of basalt located in the northern part of Central Hanford. It rises between 400 and 500 feet above the surrounding terrain to an elevation of over 1,050 feet. Its height and east-west orientation provide views of the facilities in the north part of Central Hanford, such as the B, C and N Reactors, and other visual features, such as the Columbia River, Wahluke Slope, and Saddle Mountains. Views to the south include Energy Northwest's Columbia Generating Station, the 400 Area, and other visual features such as Rattlesnake Mountain. Less imposing features to the north and south, such as roads, electrical transmission lines, borrow pits, and transmission lines, can also be seen from the top of the mountain.

Gable Butte lies approximately three miles west of Gable Mountain. At approximately ½-mile in length with an elevation of approximately 780 feet, it is a smaller feature than Gable Mountain. However, it is visually distinctive and offers broad views of the surrounding area. Views from the top of Gable Butte include most of Central Hanford and the Monument.

3.16.2.6.2 Cultural Modifications

There are several historical sites within Central Hanford that are interesting visual features. These include the Bruggeman Fruit Warehouse in the north part of Central Hanford, the White Bluffs Townsite, the Hanford Townsite, and the B Reactor. Most facilities within Central Hanford are large in scale and highly visible within Central Hanford and beyond. Because Central Hanford is located in a generally flat desert environment that offers little in the way of topographic relief or vegetation to screen the facilities, even smaller-scale facilities such as roads can be seen from great distances. In addition to scale and lack of screening, the materials used for the facilities often have colors (light or bright) and/or finishes (reflective) that accentuate their visibility. As a result, facilities in Central Hanford are visible over long distances, and virtually all of these facilities can be seen from the higher parts of the Monument, such as Rattlesnake and Saddle Mountains. Other facilities, particularly those located near the Columbia River, are also quite visible.

3.16.3 Auditory Resources

Noise is technically defined as sound waves that are unwanted and perceived as a nuisance by humans. Sound waves are characterized by frequency, measured in Hertz (Hz), and sound pressure expressed as decibels (dB). Humans have a perceptible hearing range of 31 to 20,000 Hz. The threshold of audibility ranges from about sixty dB at a frequency of 31 Hz to less than one dB between 900 and 8,000 Hz. Sound levels outside the range of human hearing are not considered noise in a regulatory sense, even though wildlife may hear at these frequencies.

Studies of the propagation of noise at the Hanford Site have been concerned primarily with occupational noise at work sites. Environmental noise levels have not been extensively evaluated because of the remoteness of most Hanford Site activities and isolation from receptors that are covered by federal or state statutes. This discussion focuses on what few environmental noise data are available. The majority of available information consists of model predictions, which in many cases have not been verified because the predictions indicate that the potential to violate federal or state standards is remote or unrealistic.

While no areas of the Monument are free from human-generated noise—few spots in the world are entirely free from intrusions like aircraft—most of the Monument is relatively quiet and has

periods when there are no noise intrusions.[82] Light aircraft and military planes do overfly the Monument; however, their numbers are limited. Other noise within the Monument can best be cataloged by lumping the units into three main areas—north of the Columbia River, the Columbia River Corridor Unit, and the Rattlesnake Unit.

3.16.3.1 North of the Columbia River (Ringold, Saddle Mountain, and Wahluke Units)

Noise in this area is generally limited, with the majority of it being generated by traffic on State Route 24. Once the visitor moves away from the highway corridor, human-generated noise comes primarily from the occasional automobile on publicly accessible Monument roads, and it is easy to move away from the limited road system on the eastern Wahluke and Saddle Mountain Units to find areas where even this noise fades away. During hunting seasons, the sounds of gunshots can be heard throughout the entire area.

On the Ringold Unit, which abuts the Columbia River, motorboat noise can be significant, especially during salmon fishing season. However, even this noise is usually mitigated by prevailing winds in the Monument. This area also has road noise, with lesser opportunities to move beyond it. Gunshots from hunting are audible in season.

Other noise sources in this area include occasional maintenance of irrigation and transmission facilities, operation of the Ringold Fish Hatchery, and cultivation of an agricultural field in the Monument. None of these sources is significant.

3.16.3.2 Columbia River Corridor Unit

The Columbia River has the greatest amount of human-generated noise in the Monument. Jetboat and other motorboat noise is possible at any time of the year and is quite high during salmon fishing seasons. As most of the major boat launches exist on either end of the Monument, motor noise tends to be greatest at the ends of the Hanford Reach (Vernita Bridge and Ringold Fish Hatchery), although at times of peak use, the White Bluffs Boat Launch can be noisy.

There is one major, continuously affected area of noise within the Columbia River Corridor Unit—the Vernita Bridge and immediate area. Traffic over the bridge generates significant

[82] For the purposes of this EIS, noise is defined as being human-generated. Natural sounds of birds and other creatures, wind and rushing water are not considered an impact and are not cataloged here. On almost any part of the Monument, the songs of birds, the rustling of grasses, the gurgling of water, or the cries of animals might be heard, enhancing the visitor's experience.

amounts of noise, and the passage of tractor-trailers creates high-decibel noise. This is also a major boat launching location, as well as an unauthorized camping area with its associated noise. The Vernita Rest Area contributes to the noise pollution, although its contribution beyond traffic is primarily through site maintenance (e.g., grass cutting, occasional construction).

In addition, there is another major source of noise pollution in the Columbia River Corridor Unit, although the source is not continuous—cleanup operations of the Hanford Site. At times, large-scale earthmoving equipment operates within the corridor, and the transitory impacts are quite large. However, these impacts are transitory, and as cleanup winds down, they will subside.

Other sources of noise include traffic and operations associated with the Midway Substation, pumping of water for Energy Northwest operations, and the occasional gunshot from hunting in season.

3.16.3.3 Rattlesnake Unit

As public access to the Rattlesnake Unit is restricted, noise impacts are lowest on this unit, being primarily restricted to the State Route 240 corridor. Once away from the public highways, it is comparatively easy to find areas where the sounds of the natural world dominate.

When the DOE borrow area becomes operational, the noise impacts may be significant in the immediate area. However, the borrow area is adjacent to State Route 240, so noise on the unit would be concentrated primarily within one corridor.

Other sources of noise on the Rattlesnake Unit include sporadic motor traffic associated with approved research and traffic and maintenance associated with communication towers, climate monitoring equipment, transmission lines, and other equipment on Rattlesnake Mountain.

3.16.4 Olfactory Resources

Air quality in the Monument is quite good (see Section 3.5). There are no permanent sources of odors on or near the Monument that affect resources or visitor experiences.

3.17 Visitor Use and Experience

The Monument provides a variety of recreation opportunities across an unusual landscape characterized by the Hanford Reach, the White Bluffs, active dune fields, rolling hills of shrub-

steppe, and basalt mountains. Beginning in 1943, security protocols for the Hanford Site placed most of the now-Monument lands in a protective buffer zone, resulting in an unparalleled preservation of the Columbia Basin's natural and cultural resources. The Hanford Reach, being never dammed nor dredged, provides the only remaining example of what the Columbia River looked like before the massive public works projects of the 20th century. The Monument's wealth of natural features attract diverse recreation interests, with the most sought-after pursuits being fishing for salmon, steelhead, sturgeon and small-mouth bass; hunting for waterfowl, upland birds, and deer; non-motorized and motorized boating; wildlife observation; and environmental education. The Monument offers excellent seasonal opportunities to pursue these activities either in complete solitude, or with very low encounter rates with other people; however, such experiences are limited during popular fishing and hunting seasons.

3.17.1 Public Use Acreages

Currently, 74,392 acres of the Monument[83] are open for public use from two hours before sunrise to two hours after sunset, including the 46.5-mile stretch of the Hanford Reach within the Monument.[84] Of the remaining Monument lands, 110,383 acres are accessible only by special permit for research or educational purposes, and 10,825 acres are off-limits due to ongoing DOE environmental clean-up and restoration activities.

3.17.2 Visitor Facilities

Visitor facilities are limited, as are access points. Visitors primarily access the Monument by automobile or by boat. Visitor facilities consist of gravel and dirt access roads, parking areas, several primitive boat launches, and one concrete boat launch. Amenities such as vault toilets, garbage pick-up, and water are not provided, although portable toilets are provided seasonally at the White Bluffs Boat Launch. There are no visitation fees.

3.17.2.1 Public Access Roads

Access to the Monument is provided by state highways and county roads traversing adjacent to and sometimes through the Monument. Table 3-15 provides a summary of administrative, public and other road miles by management unit.

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[83] This includes 600 acres of McNary National Wildlife Refuge islands that are open to waterfowl hunting only.

[84] The Monument is only open to day use at this time, with a day being defined as beginning two hours before sunrise and ending two hours after sunset.

3.17.2.1.1 Wahluke Unit Roads

There are three main roads providing public access within the Wahluke Unit—Ringold, White Bluffs, and Saddle Mountain Roads. The graveled Ringold Road runs northwest from the Wahluke Unit's southern boundary for approximately eight miles, at which point the road is closed to motorized vehicles due to public safety concerns related to erosion. Eight small parking areas are maintained along the Ringold Road to provide access to the Columbia River and adjacent upland areas. The graveled White Bluffs Road provides access from State Route 24 to the White Bluffs Boat Launch, to a dirt road accessing the WB-10 Ponds, and to an undeveloped scenic overlook with vistas of the Columbia River, White Bluffs, and Hanford Site. The graveled Saddle Mountain Road provides access from State Route 24 to the Saddle Mountain crest and adjacent public lands administered by the BLM.

3.17.2.1.2 Riverlands and Vernita Bridge Unit Roads

The paved Midway Road provides access from State Route 24 to the Riverlands Unit. State Route 24 provides access to the Vernita Rest Area, a WSDOT facility located south of the Vernita Bridge. Vehicle access to the north shore of the Columbia River is from State Route 243 via a gravel road and several primitive routes.

3.17.2.2 Boat Launches

Within the Monument, three primary boat-launching areas provide public access to the Columbia River (see Map 20). The undeveloped Vernita Bridge area consists of approximately one mile of shoreline west of the bridge on the north side of the river where people launch their boats in several locations. The White Bluffs Boat Launch consists of two narrow concrete lanes. Parking Lot 7 along the Ringold River Road provides a gravel boat launch suitable for four-wheel-drive vehicles. A fourth, seldom-used, primitive launch also exists in the Riverlands Unit, and this area is closed to public access.

Other boat launching areas can be found adjacent to the Monument. Up-river, several user-defined boat launches just downstream of Priest Rapids Dam provide access to the Monument. Immediately downstream of the Wahluke Unit, a primitive launch can be found at the Ringold Fish Hatchery and is managed by the WDFW. Parks in the Tri-City area include thirteen developed boat launches, which provide access more than ten river miles downstream of the Monument.

The Monument also has two boat launches controlled by the DOE and used for administrative purposes. One is a concrete launch located on the south river shore across from the White Bluffs

Boat Launch. The other is a primitive launch located at the historic Hanford Townsite. Public access is not allowed at either of these launches.

3.17.3 Recreation Use

Total annual recreation use in the Monument is estimated at 49,000 visits, or 30,000 visitor days.[85] Existing visitor use is described in Table 3.10. Anecdotal information indicates a trend of increased visitation since the June 9, 2000, Monument designation. Many of the recreation activities that occur in the Monument are projected to increase over the next twenty years. Table 3.11 details current and future participation in certain recreation activities currently occurring in the Monument (Cordell 1999). These activity participation trends are based on estimated changes in population, changes in the supply of recreational opportunities, and changes in demographic variables such as age, race and income.

In addition to increases in activity participation rates, population changes will also likely affect future use of the Monument. Traditionally, most visitor use of the Monument is from Washington State residents, mainly from the eastern portion of the state. It is estimated that over 80% of current visitors to the Columbia River are from counties in proximity to the study area (Benton, Franklin, Grant, Umatilla and Walla Walla) (Anderson et al. 2002). Table 3.12 details population projections for the counties adjacent to the Monument, eastern and western Washington, nearby states, and the Pacific Region. This table indicates that rapid growth is projected to continue at least until the year 2020. This growth in population will likely increase the number of visitors and recreation demand in the Monument. Another factor that will likely contribute to increased visitation in the Monument is the construction of the Visitor Center, scheduled to be open for visitors in April 2008.[86]

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[85] Recreation use is based on best professional judgement. The FWS, through the University of Idaho, conducted a visitor use and satisfaction survey, which has provided a more accurate picture of visitor use patterns and helped form this estimate. One visitor day is equivalent to twelve visitor hours.

[86] The Visitor Center is being planned and developed near the confluence of the Yakima and Columbia Rivers in the city of Richland through a partnership between the Richland Public Facilities District; Columbia River Exhibition of History, Science, and Technology Museum; Friends of the Hanford Reach National Monument; Tri-Cities Visitor and Convention Bureau; regional Native American tribes; and the FWS. The Visitor Center will provide interpretation and education programs about the Monument and other regional interests and destinations.

Table 3.10. Approximated Hanford Reach National Monument Visitation, 2004.[1]

Public Use Activity	Visitor Days[2] (Approximation)
Big Game Hunting	200
Upland Game Hunting	400
Migratory Bird Hunting	1,000
Fishing	20,000
Wildlife Observation	500
Wildlife Photography	70
Education and Interpretation	250
Hiking	330
Non-Motorized Boating	670
Motorized Boating	2,000
Commercial River Trips	1,880
Stargazing	200
Equestrian Use	330
Beach Use	1,670
Driving for Pleasure	330
Total Visitor Use	30,000

Notes:
[1] Best professional judgement.
[2] One visitor day is equivalent to twelve visitor hours.

3.17.4 Recreation Opportunities

The Monument provides for a wide variety of outdoor recreation activities. Use is currently low, but this is expected to increase as the Monument becomes better known and additional visitor facilities are provided.

3.17.4.1 Fishing

The Hanford Reach attracts anglers from around the Northwest, providing excellent opportunities to catch fall Chinook salmon, steelhead, sturgeon, whitefish and small-mouth bass. While bank and float-tube fishing is pursued by some anglers, most fishing occurs from motorboats. Jetboats are preferred by many anglers, with their low draft well suited to conditions on the Hanford Reach's shallow water sections and frequent water level fluctuations from upriver dam operations. During the fall Chinook salmon season, boat launches in the Monument and at the Ringold Fish Hatchery are at capacity, with many anglers choosing to

avoid crowds by launching from Tri-City area parks. The Vernita Bridge Unit, currently administered by the WDFW under a permit agreement with the DOE, attracts heavy use from anglers willing to trailer over rocky terrain and launch from unimproved shoreline areas. Although the DOE lease prohibits camping, visitors camp in this area year-round, with particularly heavy use during the northern pike minnow and fall Chinook salmon seasons.[87] The Vernita Bridge area has been the focus of WDFW efforts to replace the existing primitive launch areas with a developed boat launch.

Table 3.11. Pacific Region and National Outdoor Recreation Participation Trends (2000-2020).

Activity	Pacific Region[1,2]			National[2]		
	2000	2020	Percent Change[3]	2000	2020	Percent Change[3]
Non-consumptive Wildlife Activities	18.036	22.879	0.27	121.368	150.543	0.24
Sightseeing	20.165	26.270	0.30	119.07	149.688	0.26
Hiking	11.772	14.606	0.24	49.234	58.794	0.19
Walking	22.788	28.274	0.24	137.711	161.777	0.17
Motorboating	6.741	8.316	0.23	48.410	56.870	0.17
Visiting A Beach/Water	22.356	27.531	0.23	130.620	154.256	0.18
Horseback riding	2.520	3.096	0.23	14.586	17.589	0.21
Canoeing	1.272	1.560	0.23	14.382	16.215	0.13
Visiting Historic Places	14.904	18.354	0.23	93.704	116.688	0.25
Nonpool Swimming	12.296	14.964	0.22	80.443	94.501	0.17
Biking	10.388	12.642	0.22	59.696	73.472	0.23
Picnicking	16.906	20.698	0.22	102.232	122.875	0.20
Family Gathering	20.651	20.090	0.21	128.752	153.512	0.19
Primitive Camping	5.880	6.888	0.17	28.000	29.120	0.04
Fishing	7.875	9.000	0.14	59.637	71.217	0.19
Hunting	1.598	1.343	-16%	18.042	16.926	-6%

Notes:
[1] The Pacific Region is defined as Alaska, California, Hawaii, Oregon and Washington.
[2] Millions of participants.
[3] The percent change in activity participation was not tested for statistical significance.

[87] Area tribes have expressed concern that recreation use occurring in this area is harming cultural resources.

Table 3.12. County, State, and Regional Population Estimates and Forecasts Through 2020.

Area	2000 Population	Projected 2020 Population	2000-2020 Percent Change[1]
Washington Counties Near the Monument			
Adams	16,428	20,919	0.27
Benton	142,475	177,388	0.25
Douglas	32,603	44,920	0.38
Franklin	49,347	64,687	0.31
Grant	74,698	95,715	0.28
Kittitas	33,362	41,776	0.25
Walla Walla	55,180	64,856	0.18
Yakima	222,581	269,401	0.21
Washington State			
Eastern	1,306,948	1,638,199	0.25
Western	4,587,173	5,907,070	0.29
Statewide	5,894,121	7,545,269	0.28
Other Areas			
Oregon	3,397,000	4,177,000	0.23
Idaho	1,347,000	1,683,000	0.25
Alaska	653,000	838,000	0.28
Pacific Region	43,687,000	59,416,000	0.36

Note:
[1] The percent change in population was not tested for statistical significance. (Source: Washington Office of Financial Management 2002, U.S. Bureau of the Census 1997.)

The WDFW authorizes fishing tournaments for game fish on the Wallulla Pool section of the Columbia River, which includes the Hanford Reach. A typical year will see approximately ten fishing tournaments within the Hanford Reach or in the nearby vicinity, all involving bass fishing. In addition, a salmon fishing contest, not associated with the WDFW, has traditionally been held during the fall Chinook season. To date, all tournament operations have been run from Tri-City area parks.

The land base of the Monument contains one body of water that is fished regularly for bass. The WB-10 Ponds, irrigation settling ponds for the SCBID Project, are located in the Wahluke Unit and impound irrigation water before its return to the Columbia River. Fishermen must walk to the ponds, where shoreline and non-motorized boat fishing is permitted.

Fishing seasons and catch limits in the Monument are regulated by the WDFW.

3.17.4.2 Hunting and Trapping

The Monument provides regionally significant waterfowl hunting opportunities (NPS 1994). Large populations of resident waterfowl and migratory ducks and geese, coupled with good conditions for hunting, make the Hanford Reach an excellent location for waterfowl hunting. Waterfowl populations are enhanced by a longstanding waterfowl sanctuary, which includes the Columbia River and lands within ¼ mile of the river between the wooden power lines to the Vernita Bridge. This area is closed to all waterfowl hunting, and the White Bluffs Boat Launch is closed to motorboats, during the winter to reduce waterfowl disturbance from watercraft. Most waterfowl hunting occurs downstream of the sanctuary near the many sloughs and islands in the Hanford Reach and along the shorelines west of the Ringold River Road. Some hunters pursue pass shooting along the White Bluffs in the Wahluke Unit; approximately twenty waterfowl hunting pits currently exist in the vicinity, but the digging of new pits is not allowed. Waterfowl hunting also occurs on the WB-10 Ponds. Vehicles can access a parking area located approximately one mile from the WB-10 Ponds; from the parking area, non-motorized means are required to access the ponds.

The Wahluke Unit provides good opportunities for upland game hunting, including deer, pheasant, chukar and California quail. Most deer hunting occurs in the Wahluke Unit south of State Route 24, while most upland bird hunting occurs in the Ringold River Road area. The WDFW has historically operated a pheasant release program from the Ringold River Road. The Wahluke Unit is also open to elk hunting, although elk from the nearby Yakima/Rattlesnake Hills herd enter the Wahluke Unit infrequently. All hunting seasons and limits are set by the WDFW; however, the FWS enforces special firearm restrictions, allowing only shotguns, muzzleloaders and archery.

Trapping is not allowed anywhere in the Monument.

3.17.4.3 Wildlife Observation and Photography

The Monument offers excellent opportunities for wildlife and wildflower observation. Although these activities are possible year-round, the best time to see wildflowers is in the spring, while the best times to view wildlife are fall, winter and spring, with the summer less attractive due to high temperatures. More than 240 bird species and 40 mammal species spend all or part of their live cycles in the Monument. Many waterfowl inhabit the Hanford Reach, including mallard, teal, gadwall, white pelican, Canada geese, and American merganser. Colonial nesting birds include the Forster's tern, California gull, ring-billed gull, and great blue and night-crowned heron. Raptors seen include bald and golden eagle, peregrine falcon, northern goshawk, prairie falcon, American kestrel, and Swainson's, ferruginous and red-tailed hawks. Other migratory birds viewed include sage sparrow, vesper sparrow, grasshopper sparrow, loggerhead shrike, sage thrasher, Brewer's sparrow, Say's phoebe, horned lark, meadowlark,

cliff swallow, kingbird, long-billed curlew, and burrowing owl. Mammals that can been viewed include elk, mule and white-tailed deer, coyote, black-tailed jackrabbit, porcupine, beaver, badger, Great Basin pocket mouse, and ground squirrel. Reptile and amphibians seen include the side-blotched lizard, northern Pacific rattlesnake, short-horned lizard, and Great Basin spadefoot toad.

3.17.4.4 Environmental Education

With the relatively recent addition of the Monument to the NWRS, FWS-sponsored environmental education programs have been limited due to staffing constraints and a focus on Monument planning efforts. The FWS has worked with a local high school and the national Hands-On-The-Land program to provide field and classroom education programs; students are assigned to create multilingual web pages showcasing the Monument's natural resources. The FWS assists the Mattawa School District with an annual Memorial Day visit and education program to the old Wahluke townsite. Many schools, universities and nature-appreciation groups use the Monument for educational field trips and activities such as wildlife observation, native plant identification, and studies pertaining to natural history, geology, paleontology, archeology, history, astronomy and riverine, riparian and shrub-steppe habitats.

The Partners for Arid Land Ecology Stewardship (PALS) is a local environmental science education program designed to improve understanding and appreciation of the arid lands of the Columbia Basin. The PALS hosts an annual teacher's institute, often using the Monument as an outdoor classroom, to help teachers learn effective ways to educate students about local ecology.

3.17.4.5 Interpretation

Interpretation of natural and cultural resources in the Monument is currently expanding to meet increasing visitor demands. A full-color informational brochure for the Monument was published and widely distributed in 2003. In 2004, Monument boundary signs were installed at four locations along State Routes 240, 243 and 24, and orientation kiosks featuring large format maps and interpretive information were installed at all major Monument entrances and at a State Route 240 pullout. Temporary information and interpretation posters are maintained on reader boards at main public use sites throughout the Monument.

When opened, the Visitor Center will provide interpretation and education programs about the Monument and other regional tourism interests and destinations. This will occur regardless of which management alternative is chosen.

3.17.4.6 Research and Astronomy

The Monument has historically been used for numerous research projects and activities, focused primarily on the ALE. Of particular note is a research laboratory operated by the University of California. The Gravitation Physics Laboratory (GPL) is located twenty-one feet underground in the south bunker of the old Nike missile site on the ALE; the GPL is operated as a remote field facility by the University of California at Irvine and PNNL. The University of California and the University of Washington conduct state-of-the-art physics experiments into very weak gravitational interactions between masses. The site was selected over other locations within the western United States for several key reasons: seismic inactivity (from natural and human-induced vibrations), low rainfall, lack of trees, an existing and well-maintained underground facility, secure location on government property, and a partnership with a national laboratory.[88]

An observatory is located on top of Rattlesnake Mountain. Built by the Battelle Memorial Institute, the Observatory is now owned and operated by the Alliance for the Advancements of Science Through Astronomy, a non-profit organization. The organization would like to use the observatory for long-range (i.e., off-site, remote-controlled operation) education. In addition to the telescope, other instrumentation associated with the observatory monitors climatological, meteorological and seismic conditions.

3.17.4.7 Boating

Boating on the Hanford Reach has been strongly linked with angling activities; however, the scenery, abundance of wildlife, and seasonal opportunities for solitude are attracting growing numbers of visitors. Both motorized and non-motorized recreational boating occurs along the entire Hanford Reach. Non-motorized boating (e.g., canoeing, kayaking) is currently constrained due to the distance between access points and restrictions on overnight use in the Monument. The majority of motorized boaters access the river from one of the boat launches within or adjacent to the Monument, while non-motorized boaters typically launch at the Vernita Bridge and take out at either the White Bluffs Boat Launch or the Ringold Fish Hatchery. There

[88] Adjacent to the ALE is another nationally important physics experiment, the Laser Interferometer Gravitational Wave Observatory (LIGO), which is a scientific collaboration of the California Institute of Technology (Caltech) and the Massachusetts Institute of Technology (MIT). Funded by the National Science Foundation, LIGO attempts to detect ripples in space-time. Two long, perpendicular tunnels, approximately each one mile in length, have mirrors that bounce a laser beam back and forth. If the two arms have identical lengths, then interference between the light beams returning to the beam splitter will direct all of the light back toward the laser. But if space-time ripples cause the distance measured by the light beam to change as the gravitational wave passes by, the amount of light falling on the photodetector varies. Unfortunately, these mirrors are highly susceptible to localized ground disturbance, so the more activity on the ALE, the more background "noise" needs to be filtered out. A sister facility in Livingston, Louisiana, operates in unison to rule out false signals and confirm that a gravitational wave has passed through the earth.

are currently no special surface water regulations (e.g., boat speed limits, no wake zones, seasonal closures) on the Hanford Reach.

Other activities related to boating within the Monument include water-skiing, personal watercraft use, and commercial sightseeing boat tours. Most water-skiing and personal watercraft use occurs during the summer in the downstream areas of the Hanford Reach in the Ringold area. There are currently no special regulations on personal watercraft or water-skiing on the Hanford Reach.

3.17.4.8 Equestrian Use

Horseback riding occurs on all areas of the Wahluke and Riverlands Unit and is not confined to designated trails. There are no designated horse trails or developed facilities for horses in the Monument.

3.17.4.9 Bicycling

Bicycling is allowed on roads that are open to vehicles, with two additional road segments open to bicycles—the closed road between Parking Lot 8 and the scenic overlook area, and the road between the WB-10 Ponds parking lot and the ponds themselves. Similar to other types of off-road vehicle use, bicycling off-road is prohibited.

3.17.4.10 Hiking

Hiking occurs on the Wahluke Unit and is not confined to trails. There are no designated hiking trails or other developed trail features (e.g., trail heads, signboards) in the Monument. Some short, user-defined trails provide access from parking areas to popular use areas.

3.17.4.11 Commercial Uses

Commercial sightseeing tours and fishing and hunting guide services occur on the Hanford Reach and the Wahluke Unit. Currently, the number of commercial operators and the number of clientele they serve is unknown; however, anecdotal information indicates a steadily increasing demand for these services.

3.17.5 Hanford Reach Jurisdiction

Several federal, state and local agencies have jurisdiction within the river corridor. The islands within the Monument are under DOE, BLM, state and private ownership. The FWS controls seven islands immediately downstream of the Monument. The DOE retains management of the south river shoreline, while the FWS manages the north shore. The WDNR has jurisdiction over the riverbed and river shores below the mean high-water mark. The Washington Department of Parks and Recreation (WDPR) oversees boat licensing. The Benton, Franklin and Grant County Sheriff's Departments enforce boating regulations on the water, and the WDFW enforces hunting and fishing regulations on the water.

3.18 Infrastructure

3.18.1 Management Resources

The operation of a national monument requires a large investment of management resources such as buildings, roads, equipment, and personnel. The sections that follow describe the current collection of resources used in management of the Monument. Many of the resources that will be needed in the future are outlined in the appendices.

3.18.1.1 Personnel

The Monument is operating with the minimum staff needed to maintain the status quo and has lost several staff over the last year to attrition. For example, the Monument lost its Archeologist and GIS Specialist; neither of these positions are slated to be refilled in the immediate future, although other staff have helped to provide GIS capacity. There are no immediate plans to refill these positions due to budget conditions. To fully implement any of the alternatives, additional staff would be needed. The staffing needed to fully implement each alternative can be found in Appendix O. The Monument currently has the following staff.

- Project Leader
- Deputy Project Leader
- Refuge Operations Specialist
- Natural Resource Planner
- Outdoor Recreation Planner
- Interpretation &Education Specialist
- GIS Specialist
- Wildlife Biologists (2)
- Biological Technician
- Equipment Engineer
- Two Maintenance Workers
- Administration Officer
- Administration Assistant

Until recently, the Monument had several seasonal workers/firefighters; the number varied according to budget and needs. Firefighting has been consolidated into a "zone," and fire fighting staff that would protect are now being managed by the Mid-Columbia National Wildlife Refuge.

3.18.1.2 Buildings

There are a number of buildings on or adjacent to the Monument that are used by the FWS in managing the Monument. It is anticipated that these facilities will continue to be used regardless of the final management alternative chosen. The siting and design of new facilities will be influenced by the chosen alternative.

Several buildings on the ALE surplus to the DOE's needs are now being utilized by the FWS as maintenance shops through a cooperative working agreement with the DOE. The primary facilities utilized by the FWS on the ALE include a garage and utility building that are used for the maintenance, repair and storage of government equipment. Additionally, a well house, pump house, and 250,000-gallon reservoir are maintained and used to provide water for fire suppression, noxious weed control, and maintenance activities. Space within these facilities is limited and provides support to FWS activities on ALE only.

A second shop is maintained by the FWS on the western boundary of the Monument in the BPA's Midway Substation. A cooperative agreement between the BPA and FWS provides a large facility for storage and maintenance of equipment and supplies and a satellite office space for maintenance crews and fire staff. This facility is a shared workspace with the BPA and therefore is designed to accommodate both agencies' needs. It provides an important link for the management of lands and facilities on the northern and southern halves of the Monument. This building also serves as an important staging area for equipment used in fire suppression activities.

A third building has been made available for the storage and maintenance of equipment on the northern half of the Monument at the Ringold Fish Hatchery. A cooperative agreement provides for the use of the WDFW's shop to store repair parts and supplies for FWS equipment while providing outside parking space for heavy equipment. The primary function of this facility is to support the WDFW hatchery operations at Ringold, but it also provides an important staging area for FWS maintenance operations on the Wahluke and Saddle Mountain Units.

3.18.1.3 Equipment

Operating a national monument requires a significant investment in equipment. For being designated as a national monument for only five years, the Monument has done a good job in

securing necessary equipment. However, as use of the Monument increases, and as the CCP is implemented, additional equipment will be needed, especially for firefighting. Some of these additional equipment needs are identified in Appendix N (RONS and MMS).

Currently, the Monument owns a grader, tracked tractor, standard tractor, backhoe, 500-gallon spray truck, dump truck, two multi-terrain loaders and attachments, eight all-terrain vehicles (four with sprayers and two with broadcast seeders), two utility trucks, two disks, culti-packer, two harrows (as well as ATV harrows), batwing and three-point mower, 1,600-gallon water tanks, a fire engine, numerous trailers (including tilt-top and an eighteen-foot flatbed), two canoes, two inflatable kayaks, several boats (including a jetboat), and numerous pickup trucks and SUVS. While this is a fairly impressive list of major equipment, it barely meets the current needs of managing a 195,000-acre national monument. Additional equipment will be needed to fulfill management goals and accommodate the public.

3.18.1.4 Communications

The FWS utilizes an integrated, interagency communication system to maintain contact with field personnel, provide timely information concerning weather and operational conditions, and respond to emergencies. The Monument uses a mix of hand-held radios, base stations, and cellular phones that are integrated with local state, county and city emergency response systems.

The FWS uses radios that are multi-band, multi-channel, and operating off of a repeater system to transmit and receive messages throughout the fifty-six-square-mile Monument. Repeaters located on Wahitas Peak and Jump-off Joe Peak relay radio signals throughout the Columbia Basin for the BLM, DOE, FWS, U.S. Forest Service (USFS), Washington State Patrol, WDFW, WDNR and Adams, Benton, Franklin and Grant County Sheriff Offices. These radios are also capable of communicating with Benton County Emergency Services during a local emergency; providing direct communication between users and vehicles without transmission through the repeaters; and providing air-to-ground communication to aircraft responding to emergencies.

Cellular phones are utilized by many emergency response agencies when radio frequencies become crowded during an incident, or to maintain privacy during sensitive situations. Cellular phones and hand-held radios do have areas where they will not work in the Monument because of topographic or geologic interference. However, it is rare that both will not work in the same area.

3.18.1.5 Columbia River Boat Access

The Columbia River is the focal point of the Monument and is the most heavily used area. There are numerous ways to access the river, both on and off the Monument.

3.18.1.5.1 Monument Access

There are three sites within the Monument providing public boat access—Vernita, White Bluffs, and Parking Lot 7.

The Vernita launch area, administered by the WDFW under DOE permit, is located on the north shore of the river west of the Vernita Bridge on State Route 243. Open year-round, this primitive launch area consists of several user-defined sites along the shoreline where motorized and non-motorized boats can be launched. While overnight use is not officially allowed here, it has occurred historically, especially during salmon sport-fishing and northern pike minnow reward seasons.

The White Bluffs Boat Launch is located on the north shore of the river south of State Route 24. Open from June 30 to September 30 each year, this site provides a concrete launch with two narrow lanes. The launch is used primarily by motorboats. The launching area also serves as a non-motorized boat take-out for paddling the upper Hanford Reach float and the put-in for the lower Hanford Reach.

Parking Lot 7 is located on the north shore of the river along the Ringold River road. Open year-round, this site consists of a primitive gravel and earthen ramp which requires four-wheel drive vehicles to negotiate.

3.18.1.5.2 Administrative Access Boat Launches

The DOE controls two boat launches on the south shore of the river—a narrow, two-lane concrete launch located across the river from the White Bluffs Boat Launch and a gravel/earthen launch at the old Hanford Town sites. The launches are within the Hanford Site's secure access zone and are not open for public use.

3.18.1.5.3 Off-Monument Access

Located immediately adjacent to the Monument, the WDFW Ringold Fish Hatchery provides a primitive launching area on the north shore. Open year-round, this area also allows overnight use, although no improvements are provided. This site serves as a motorboat launch and is also used by non-motorized boaters, primarily as a take-out for floating the Hanford Reach.

Improved public boat launch options are plentiful in the Tri-Cities area, down-river of the Monument (see Map 20). The Priest Rapids Dam, located about four miles from the Monument boundary, limits boat access upstream of the Monument, although there are several unimproved spots to launch a boat just downstream of the dam.

3.18.1.6 Other Facilities

The Monument is open to the public two hours before sunrise and two hours after sunset. In 2002, two automated gate systems were installed at the main entrances to the Wahluke Unit north of Pasco and south of State Route 24, approximately twenty-two west of Othello. These two solar-powered gate systems are automatically timed to open and close to regulate visitor access to these units. However, the gates have never been used; they may not be put into service until such time as this CCP is finalized and the public has been adequately notified.

Other facilities on the Monument that assist in controlling access, protecting resources, and facilitating recreation include roads, signs, kiosks, fences and the well house, pump house, and reservoir on the ALE.

3.18.1.7 Adjacent Areas

3.18.1.7.1 Horn Rapids County Park

Benton County's Horn Rapids Park consists of 784 acres along the Yakima River near the Monument's southwestern border. The park currently provides a day use area, interpretive kiosks, restrooms, camping and RV camping with electricity. The park's approved master plan envisions the site as a key access point for recreational activities associated with the Yakima and Columbia Rivers and the Monument.

3.18.1.7.2 Ringold Spring Fish Hatchery

The 110-acre hatchery is located about seventeen miles west of Mesa, Washington, on the north shore of the Columbia River and sits just outside the Monument's eastern-most entry point. The Ringold Fish Hatchery serves as an adult collection, rearing and release facility for spring Chinook, rearing and release for summer steelhead, and final rearing and release for fall Chinook salmon. In 1999, the hatchery added warmwater species (bass, walleye, channel catfish, tiger muskie, crappie) to its stock, making it the only warmwater hatchery in Washington.

The Ringold Fish Hatchery provides a primitive launching area for motorized boats and as a take-out point for non-motorized boats floating the Hanford Reach. Open year-round, this area also allows overnight use, although conditions are primitive.

3.18.2 Transportation

The Monument is readily accessed through state highways, county and city roads, and by boat. Additional transportation infrastructure on or directly related to the Monument includes parking facilities, bikeways and trails, public transportation facilities and services, railroads and airports. This section presents the current regulatory setting under which transportation conditions are assessed, as well as a description of the existing transportation infrastructure in the project area and surrounding region.

3.18.2.1 Transportation Jurisdictions

The Monument covers a large area that crosses multiple jurisdictional boundaries. The transportation system in the project area falls under the following jurisdictions.

- The highways that serve the project area are state routes maintained by the WSDOT. The WSDOT is divided into six regions throughout the state of Washington. In the Monument vicinity, the geographic area north of the Columbia River falls under the jurisdiction of the North Central Region, and the geographic area south of the Columbia River falls under the jurisdiction of the South Central Region.

- The state routes that serve the Monument are not designated as highways of statewide significance (described in more detail later in this section), and thus acceptable levels of traffic operations are defined by local standards. The largest area of the Monument (south and west of the Columbia River) is located within Benton County. The north portion of the Monument (north of the Columbia River) is located in Grant County, and the narrow east portion (east of the Columbia River) is located in Franklin County. The state highways that serve the Monument are located in Benton and Grant Counties and are subject to the operations standards of the counties in which they are located.

- The eastern portion of the auto tour routes proposed under Alternative D would include local one or more local roadways located in Franklin County.

- Local roadways located within the Monument are under the jurisdiction of the agency that manages the land. In most cases, this will be either the FWS or the DOE. The BPA and SCBID also own access roads and easements within the Monument.

3.18.2.2 National Highway System

The National Highway System (NHS), as defined under the Intermodal Surface Transportation Efficiency Act (ISTEA), is one component of the National Transportation System. The NHS's purpose is to focus resources on roadways that are the most important to interstate travel and national defense; roadways that connect other modes of transportation; and roadways that are essential for international commerce. The entire interstate system is a component of the NHS and includes a large percentage of urban and rural principal arterials, the defense-strategic highway network, and strategic highway connectors.

3.18.2.3 Highways of Statewide Significance

The Level of Service Bill (State House Bill 1487, enacted in 1998) required the WSDOT to identify highways of statewide significance (HSS). Criteria for establishing HSS routes includes National Highway System designation, rural highways serving statewide travel, urban routes that are links to rural HSS, principle arterial ferry routes, long-haul freight routes, and connections to ports. Improvements along HSS routes are to be considered for priority funding by the Washington State Transportation Commission.

As noted, there are no HSSs in the Monument.[89]

3.18.2.4 Roadway Level of Service

Level of service (LOS) designations are qualitative measures of congestion that describe operational conditions within a traffic stream and take into consideration such factors as volume, speed, travel time, and delay. LOS is represented by letter grades A through F. Table 3.13 summarizes the typical traffic conditions for each of the level of service designations. LOS A through C implies traffic flows with minimal delay, while LOS D and E imply conditions that approach capacity, and LOS F implies unstable flow with potential for substantial delays (Transportation Research Board 2000).

[89] There are HSSs nearby—I-82 from the Yakima County Line to the Oregon State Line; I-182 from I-82 to State Route 12; State Route 240 from Stevens Drive to I-182; State Route 240 from I-182 to State Route 395; State Route 395 from I-82 to I-182; State Route 395 from I-182 to the Adams County Line; State Route 17 from State Route 395 to the Adams County Line; State Route 12 from I-182 to the Columbia County Line; and State Route 125 from the Oregon State Line to State Route 12.

Table 3.13. Description of Level of Service Designations.

LOS Level	Description
A	A condition of free flow in which there is little or no restriction on speed or maneuverability caused by the presence of other vehicles.
B	A condition of stable flow in which operating speed is beginning to be restricted by other traffic.
C	A condition of stable flow in which the volume and density levels are beginning to restrict drivers in their freedom to select speed, change lanes, or pass.
D	A condition approaching unstable flow in which tolerable average operating speeds are maintained, but are subject to sudden variations.
E	A condition of unstable flow in which operating speeds are lower with some momentary stoppages. The upper limit of LOS is the capacity of the facility.
F	A condition of forced flow in which speed and rate of flow are low, with frequent stoppages occurring for short or long periods of time; with density continuing to increase, which causes the highway to act as a storage area.
Source: Washington State Department of Transportation 2002	

LOS standards represent the minimum performance level desired for transportation facilities and services within the region. They are used as a gauge for evaluating the quality of service on the transportation system and can be described by travel times, freedom to maneuver, traffic interruptions, comfort, convenience and safety. The Washington State Growth Management Act (RCW 36.70A) states that these standards should be regionally coordinated. The standards are used to identify deficient facilities and services in the transportation plan and are also to be used by local governments to judge whether transportation funding is adequate to support proposed land use developments.

Within Washington, highways that are not classified as HSS may be held to the locally adopted LOS standards of the jurisdictions in which they are located. The Benton-Franklin Council of Governments has established a uniform LOS D as the standard in urban areas and LOS C in rural areas. At the discretion of each jurisdiction, a higher or lower LOS may be used on selected portions of the urban transportation network. Benton County has adopted a standard of LOS C for major collectors and minor arterials located outside of the Benton County Urban Growth Area. Lower classified roadways in the unincorporated County do not have designated LOS values (Benton County 2003). Franklin County has adopted a standard of LOS C for rural county roadways (Franklin County 2000). Grant County has adopted the following standards for roadways within the unincorporated County: LOS B for roadways in rural areas; LOS C for rural state highways; and LOS D for roadways in urban areas (Grant County 1999).

Within the Monument, State Routes 24 and 240, as well as those that provide additional direct access to the area (State Routes 225 and 243), are subject to local LOS standards; LOS C has been identified as the standard for all functionally classified roadways that would potentially be affected by the CCP.

3.18.2.5 State Highway Design Standards

State Routes 24 and 240 are classified as limited-access highways under the full jurisdiction of the WSDOT. Limited-access highways are those facilities for which WSDOT has purchased access control. Standards for limited-access highways are set forth in the WSDOT Design Manual (WSDOT 2003). Limited-access highways may be designated as having the following levels of access controls.

- ***Full access control.*** This is the most restrictive level of limited access, allowing access by interchange only.

- ***Partial access control.*** This is the second most restrictive level, allowing at-grade intersections with selected public roads; there may be some crossings and driveway approaches at-grade. No direct commercial access is allowed.

- ***Modified access control.*** This is the least restrictive level, with characteristics similar to partial access control facilities, except that direct commercial access is allowed.

The highways in the vicinity of the Monument fall under the definition of partial access control facilities. No new intersecting access roadways are being proposed under any of the alternatives, but an upgrade of existing access points/intersections is proposed under each of the alternatives. Both State Routes 24 and 240 are designated as minor arterials in the project vicinity (Benton-Franklin Council of Governments 2001). The WSDOT has defined the following standards for access points on minor arterials with partial access control.

- At an at-grade intersection, control will be established and acquired long the crossroad for a minimum distance of 300 feet from the centerline of the highway.

- If another frontage or local road is located within 350 feet of the at-grade intersection, limited access will be along the frontage or local road for the required 300 feet and for an additional minimum distance of 130 feet from the centerline.

- At-grade intersections should be spaced at a minimum of 0.5 mile, if the average daily traffic is less than 2,000 vehicles. If the average daily traffic is expected to be greater than 2,000 vehicles within twenty years, grade separation should be planned for within that time period.

- Bus stops for both common carriers and school buses are not allowed, except at railroad crossings, at intersections with necessary pullouts that have been constructed by the state, at shoulder widenings that have been provided for mail delivery service, and at designated school bus loading zones that have been approved by the WSDOT.

- Pedestrian crossings are allowed when grade-separated.

- Pedestrian and bicycle traffic is allowed, consistent with the "Rules of the Road" (RCW 46.61), except where unusual safety conditions support prohibition.

- Pedestrian and bicycle trails are allowed with WSDOT headquarters approval, consistent with the "Rules of the Road." When a trail is allowed, it must be documented on the right-of-way and limited access plan and include the location of the trail, movement notes, and where it crosses the highway.

A limited-access deviation would need to be requested in cases where one or more of these standards could not be applied.

3.18.2.6 Access Rights

Access rights are legally defined for all roadways that intersect with state highways. In the Monument, access definitions most likely date back to agreements with the DOE and could potentially date back prior to the DOE's jurisdiction. Thus, it is highly unlikely that the uses defined under existing access deeds for Monument roadways include recreational uses that are proposed in this CCP. The WSDOT maintains access deeds and has a procedure in place for applying to revise existing legal access agreements.

3.18.2.7 Washington State/Local Transportation Plans

Transportation is guided by the plans and policies that have been adopted by the state and local jurisdictions that operate the roadways located within the study area. Plan elements have been developed to be consistent with transportation policy and plans that have been adopted at the state and local levels, as described in the following sections.

3.18.2.7.1 Washington Transportation Plan

The Washington Transportation Plan (WTP) lays out policies to identify transportation problems and provide solutions. Although the WTP focuses on regional planning efforts, it also addresses important statewide goals. In the 1998 legislative session, the Washington State Legislature directed the WSDOT to focus the next WTP update on five primary goals for the state

transportation system: congestion relief, preservation, safety, freight mobility, and seamless connections.[90]

The WTP addresses the essential and interconnected roles of the Regional Planning Organizations and their local jurisdictions and the important transportation issues of tribal governments in Washington State. It highlights the role of the WSDOT to maintain, preserve and improve the transportation system while meeting other societal needs.

3.18.2.7.2 Benton-Franklin Council of Governments

The mission of the Regional Transportation Plan is to develop and maintain a balanced regional transportation system that provides access and mobility for people, goods and services in a safe, convenient and energy-efficient manner. The goals, policies and strategies developed through the transportation planning process, and subsequently adopted by the Benton-Franklin Council of Governments Board, were developed to guide the regional transportation planning process for the next twenty years. The goals and policies of the Regional Transportation Plan include a transportation system that is integrated with local land use policies, meets the needs of sustained economic growth, and is consistent with local, regional, state, and federal policies; comprehensive least-cost solutions for transportation deficiencies; lower cost solutions that include transit, vanpool/carpool, demand management, and non-motorized modes in lieu of capacity expansion; and a system that assures improvements support the values of communities and neighborhood structures.

3.18.2.7.3 Benton County

Transportation goals and policies defined in the Benton County Comprehensive Plan are consistent with those defined at the state and regional levels. The following goals particularly apply to roads in the Monument.

- Goal 20: Provide safe, convenient, economic and multi-modal transportation networks, with new construction and other county public works projects designed to be compatible with the rural character and serve the transportation demands of the Land Use Element, at designated levels of service, and consistent with all other relevant provisions of the Comprehensive Plan.

[90] In addition to the interregional and statewide goals listed above, the WTP addresses other investment needs via seventeen other goals for the state transportation system. See www.benton-franklin.cog.wa.us/RTP_Chapter10.pdf for the complete list.

- Goal 21: Provide adequate roads that safely handle anticipated traffic and serve a diversified area of industrial, agricultural and residential uses.

- Goal 22: Provide county road right-of-ways wide enough for off-road walking, jogging and horseback riding, from one area to another safely.

- Goal 23: Improve the cost effectiveness of capital spending by coordinating new road construction with all jurisdictions and service districts/providers.

- Goal 26: Provide an integrated network of trails and paths for non-vehicular recreation and travel throughout the rural areas and connecting to urban trails and paths, as part of an overall county/city trails system.

- Goal 27: Provide safe pedestrian ways and bicycle routes, separate from vehicle roadways where feasible.

3.18.2.7.4 Grant County

Transportation goals and policies defined in the Grant County Comprehensive Plan are consistent with those defined at the state and regional levels. The following goals particularly apply to roads in the Monument.

- Goal T-1: Establish levels of service for transportation facilities and determine what improvements are needed in order to achieve and maintain the standards for existing and future populations and to repair or replace existing transportation facilities.

- Goal T-2: Complement the land use and rural areas element of the Grant County Comprehensive Plan.

- Goal T-3: Coordinate with neighboring cities and other transportation providers.

- Goal T-4: Promote safe and efficient access to land, while maintaining the integrity of the arterial roadway system and minimizing environmental impacts of transportation systems.

3.18.2.8 Transportation Infrastructure

A comprehensive inventory of all transportation facilities provides a sound basis for effective planning. Consistent with the requirements of the Washington Growth Management Act, cities maintain inventories of transportation facilities, which include roadway network, parking,

transit, non-motorized, air and rail. These elements of the regional transportation system are described in the following sections.

3.18.2.8.1 Roadway Network

Transportation roadway systems consist of a hierarchy of highways and streets that provide the dual functions of access to land and development and through-movement for travelers. Roadways are classified based on the relative degree to which they provide these functions. Land use policies and street standards typically vary according to the street function. For example, most jurisdictions designate minimum right-of-way requirements, stopping and entering sight distances, roadway width, design speed, design traffic volumes, access control, and sidewalk requirements in accordance with an adopted classification system. These requirements are usually codified in the jurisdiction's municipal code and/or adopted as street standards.

Washington State law requires that cities and counties adopt a street classification system that is consistent with state and federal guidelines (codified in RCW 35.78.010 and RCW 47.26.090). Each local jurisdiction is responsible for defining its transportation system into the following functional classifications: freeway, principal arterial, minor arterial, and collector. All other roadways are assumed to be local access streets.

A **freeway** is a multilane, high-speed, high-capacity roadway intended exclusively for motorized traffic. All access is controlled by interchanges and road crossings are grade-separated.

A **principal arterial** is an inter-community roadway that connects major community centers and facilities and is often constructed with limited direct access to abutting land uses. The primary function of principal arterials is to provide a high degree of vehicular mobility; however, they may play a minor role in providing land access. Principal arterials serve high-volume corridors, carrying the greatest portion of through or long-distance traffic within a community.

A **minor arterial** is an intra-community roadway, bounded by the principal arterial system, which connects centers and facilities within the community and serves some through-traffic, while providing a greater level of access to abutting properties. Minor arterials connect with other arterial and collector roads extending into the urban area.

A **collector** is a roadway designed to fulfill both functions of mobility and land access. Collectors typically serve intra-community trips, connecting neighborhoods with each other or activity centers, while also providing a high degree of property access within a localized area. These roadways collect vehicular trips from local access roads and distribute them to higher classified roadways.

A **local access road** is a roadway designed with a primary function of providing access. Typically, they are only a few blocks long and are relatively narrow. All roadways that have not been designated as arterials or collectors are considered to be local access roads.

3.18.2.8.1.1 State Highways

Two state routes run through the Monument—State Route 24 and State Route 240. Their routes in the Monument are described below.

State Route 24 traverses the northwest corner of Benton County (12.8 miles). This minor arterial extends from the city of Yakima to State Route 26 at Othello. One function of this route is access to the west gate of the Hanford Site at the junction of State Route 24 and State Route 240.

State Route 240 extends forty miles between State Route 24 at the Hanford West Gate and the cities of Richland and Kennewick. This route traverses the western portion of the Hanford Site and is highly utilized by Hanford commuters. In conjunction with State Routes 24 and 243, State Route 240 carries regional freight and passenger traffic. From State Route 24 to Stevens Drive in Richland, the roadway is a two lane minor arterial. The Richland Bypass segment, and the segment from I-182 to U.S. 395 in Kennewick, are four-lane principal arterials. These segments flow at or near capacity during the daily Hanford Site work commute. Regional transportation studies have addressed both major capacity improvements and traffic management strategies for these congested commute segments. The Richland Bypass segment is currently being expanded to six lanes, as is the segment from I-182 southeast to the Columbia Center Interchange.

An additional state route provides direct access to the southwest area of the Monument. State Route 225 is an eleven-mile major collector extending from I-82 at Kiona, through Benton City, to State Route 240 at Horn Rapids. DOE Route 10 extends on into Central Hanford. Hanford Site commuters dominate peak volumes on this two-lane roadway.

3.18.2.8.1.2 Federal/Interstate Highways

Four federal interstates and U.S. highways constitute the east-west and north-south backbones of the regional highway system. These routes carry the vast majority of freight and goods movement and automobile traffic throughout the region.

I-82 is an interstate freeway extending from I-90 near Ellensburg, Washington, to I-84 near Hermiston, Oregon. This four-lane freeway traverses down the lower Yakima Valley, entering Benton County northwest of Prosser. The route follows the Yakima River past the Kiona/ Benton City area, traverses southeasterly along the fringe of the Tri-Cities urban area, intersects

U.S. 395 south of Kennewick, then traverses southerly over the Horse Heaven Hills to enter Oregon at Umatilla.

I-182 is a 15-mile interstate spur route from I-82 west of the Tri-Cities to U.S. 395, State Route 397, and U.S. 12 at Pasco. The highway descends across the Yakima River to Richland, where it expands from four to six lanes, crosses the Columbia River into the west Pasco/Riverview area, then reverts back to four lanes at the interchange with the south leg of U.S. 395 at Pasco. The freeway extends through an interchange with State Route 397 and northerly extending U.S. 395, then becomes U.S. 12 extending on into Walla Walla County.

U.S. 12 is a cross-state route extending from the Washington Coast at Aberdeen, over the Cascades via White Pass, down the Yakima River Valley via I-82 and I-182 to Pasco, then on through southeastern Washington to Lewiston, Idaho, and over Lolo Pass to Missoula, Montana. At East Pasco, U.S. 12 extends from I-182 as a four-lane expressway across the Snake River into Walla Walla County near Burbank. There the highway intersects State Route 124, reduces to two lanes, then extends southerly along the Columbia River to a junction with U.S. 730 near Wallula. The highway then turns easterly to Walla Walla, expands to four lanes through the urban area, then reverts to two-lane extending through Waitsburg and on toward Idaho.

U.S. 395 is a highway of national significance that runs between Mexico and Canada. From Umatilla, Oregon, to south Kennewick, the highway is shared as I-82. From I-82, the highway extends north as a four-lane facility through Kennewick and Pasco. A 1.5-mile segment in Kennewick has numerous intersections, many with signals; consequently, that segment functions more as a city arterial than an urban expressway. At Pasco the highway utilizes two miles of east-west I-182, then resumes its northeasterly course up through Franklin County toward I-90 at Ritzville. The thirty-eight-mile segment from Pasco to the Adams County line has four lanes with some scattered rural intersections and interchanges. Efforts are on going to replace some of the intersections with interchanges. In the Tri-Cities region, the daily traffic volume includes 30–35% trucks.

3.18.2.8.1.3 Other State Highways

The other state routes as described below, serve primarily as local roadways and carry lower traffic volumes.

State Route 14 is an east-west route along the Columbia River from Vancouver (I-5) to Plymouth (I-82), south of the Tri-Cities. This route provides a two-lane alternative to I-84 on the Oregon side of the Columbia River. The segment from Plymouth westerly to Paterson, in conjunction with State Route 221 northerly to Prosser, provides an alternative route to the longer I-82 loop from Prosser to Umatilla, Oregon, via the Tri-Cities.

State Route 224 provides a ten-mile connection, from I-82 (Kiona/Benton City) through West Richland to Richland (State Route 240). The route is a two-lane major collector from I-82 to downtown West Richland, then a four-lane minor arterial extending to State Route 240. Traffic on this route is oriented to Richland and Central Hanford work sites and local freight movement.

State Route 397 is a two-lane collector from the Finley area to East 10th Avenue in Kennewick. From 10th Avenue, across the river, and through East Pasco to the I-182/State Route 395 interchange, the route is a principal arterial (5.6 miles). Much of this urban section has four lanes. This route serves industrial sites along the river; therefore trucks are common.

State Route 124 is a two-lane minor arterial extending east from U.S. 12 at Burbank through Prescott to U.S. 12 at Waitsburg, a distance of approximately forty-five miles. This route is seventeen miles shorter than the U.S. 12 routing down through Walla Walla. Both cars and trucks (16–20%) use this shortcut.

3.18.2.8.2 National Highway System

The following roadways in Benton, Franklin and Walla Walla Counties are included in the NHS:

- I-82 and I-182.
- State Route 240/Stevens Drive from I-182 to the Hanford Site boundary.
- State Route 395 from I-82 at Kennewick to the Adams County line.
- State Route 17 from Mesa to the Adams County line.
- State Route 12 from Pasco to the Columbia County line.
- State Route 125 from Oregon to State Route 12 at Walla Walla.
- North 20th Avenue from I-182 to the Tri-Cities Airport.
- Airport Way from State Route 12 to the Walla Walla Airport.

3.18.2.8.3 Scenic and Recreational Highways

Established by the state legislature in the 1960s, scenic and recreational highways are recognized for the subject values. These routes, or route segments, are part of the National Scenic Byways System and are administered by the Heritage Corridors Program of the WSDOT. Management

emphasis is on preservation, maintenance and enhancement of heritage resources; on access to those resources; and on related tourism. Local partnerships, long-term stewardship, and public involvement are key elements of successful heritage corridors. The Monument has no state-designated scenic byway segments, but the three-county region has the following scenic byways.

- State Route 14 from the Klickitat County line to I-82.
- I-82 from the Oregon State line to the junction with State Route 395.
- State Route 17 from State Route 395 to the Adams County line.
- State Route 12 from the Snake River (East Pasco) to the Columbia County line.
- State Route 261 from State Route 260 to the Columbia County line.

3.18.2.8.4 Pullouts in Project Area

Two pullouts are located on the segment of State Route 24 north of the Columbia River. The more western pullout includes an informational kiosk that describes the B-Reactor. The more eastern pullout includes an informational kiosk that describes the Monument.

3.18.2.8.5 Parking

Existing public parking lots within the Monument boundaries are primarily located along the Columbia River within the Wahluke Unit. The existing parking lots, and their approximate capacities, are summarized in Table 3.14.

3.18.2.9 Refuge Roads

The refuge is crossed by a large number of non-public roads. Some are, of course, roads constructed by the DOE for Hanford Site operations. Some are remaining from military use of the land in protection of the Hanford Site. Others are roads within transmission line and irrigation ditch easements, granted to the BPA and to local irrigation districts, respectively. Many of these roads are open to public use.[91] Most use occurs on these roads in the spring and fall and is associated with salmon fishing, hunting and wildflower observation.

[91] The roads associated with utilities are closed to public use.

Table 3.14. Existing Parking Areas in the Monument.

Parking Lot	Approximate Capacity (Parking Spaces)
1	15
2	20
3	4
4	4
5	4
6	4
7	15
8	4
WB-10 Pond	8
White Bluffs Boat Ramp	20

A refuge road inventory of the Monument was conducted in 2001 pursuant to the Transportation Equity Act for the 21st Century (TEA-21; Public Law 105-178). Under this legislation, refuge roads were defined as those roads that provide access to or within a unit of the NWRS and for which title and maintenance responsibility is vested in the U.S. government. The inventory resulted in twenty-nine miles of public use roads identified in the Monument, with seventeen paved and twelve unpaved.

All public use roads occur on the north side of the Monument and are former DOE and military roads associated with access to Nike missile sites and anti-aircraft gun emplacements. All of these roads were once paved and well maintained, although they are currently in various stages of disrepair. Public access on many of these roads began in 1971 when the WDFW, under permit from the DOE, took over management of a 57,000-acre land parcel (the Wahluke Slope Wildlife Recreation Area). Public access to the eastside of the Monument, both north and south of State Route 24 and at the state-managed Ringold Fish Hatchery, is via the same roads as under WDFW management.

As noted, many of the public use roads are in poor shape. A TEA-21 project, administered by the U.S. Department of Transportation/Federal Highways Administration reconditioned approximately twenty miles of one public use road last summer, transforming a deteriorating asphalt and river cobble road into a uniformly graveled road. This road serves as the main south artery from State Route 24 to access the White Bluffs Boat Launch and the WB-10 Ponds and is the main artery from the Ringold Fish Hatchery to parking lots and a primitive boat launch in the Ringold area.

In addition to the public use roads, there are approximately 250 miles of administrative roads in the Monument, with the majority on the ALE and Saddle Mountain Units. Administrative roads are used to carry out day-to-day management of the Monument. However, many of the

administrative roads are also used by other entities such as public utility districts, irrigation districts, BPA, DOE and many contractors to maintain their equipment or fulfill their respective missions. These roads are closed to public use, as are the roads specifically associated with utilities. Most of these roads are maintained as gravel or two-tracks over native materials. Access to most of these roads is through locked gates off State Routes 225, 240, and 24.[92]

Some of these administrative roads receive heavier traffic than others. The 106 Road, for example is quite heavily used by the DOE and its contractors, as well as by the FWS. It is one of the few paved administrative roads in the Monument and is jointly administered by DOE and the FWS. Access to the 106 Road is through a locked gate off of State Route 225, which provides a connection to a Monument maintenance facility. Most traffic on this road is associated with DOE-permitted activities to monitor and maintain communications equipment and towers on the summit of Rattlesnake Mountain.

Table 3.15. Miles of Roads by Management Unit.

Unit	Administrative Road Miles	Public Road Miles	Other Road Miles	Total Miles
Ringold	1.1	10.0	0.0	11.1
Wahluke	49.0	40.0	0.0	89.0
Saddle Mountain	14.0	9.0	0.5	23.5
River Corridor	3.8	9.2	0.0	13.0
Rattlesnake	83.0	24.0	0.0	107.0
Total	150.9	92.2	0.5	243.6

3.18.2.10 Transit

Transit service in the region is provided by Ben Franklin Transit in the Tri-Cities urban area. However, there is no transit service to or in the Monument.

3.18.2.11 Non-Motorized Transportation

The two state routes that directly serve the Monument area are not well suited for bicycle travel. There is an absence of consistent paved shoulder along the highways, requiring bicyclists to potentially travel in the highway lanes.

[92] Since establishment of the Monument, many two-tracks over native material have been closed to protect resources, and the BPA and irrigation districts have closed access along their respective easements.

Since the surrounding land is mainly undeveloped and government-owned with restricted access, no pedestrian generators are identified under existing conditions. The existing pullouts along the highways are typically accessed by car, but their widths are sufficient for people to walk around the pullout area while maintaining separation from the highway traffic.

3.18.2.12 Rail

Regional rail service is provided by the Burlington Northern-Santa Fe Railway, AMTRAK, the Union Pacific Railroad, the Tri-City and Olympia Railroad, and the Blue Mountain Railroad. However, there is no rail service currently operating to or in the Monument. There are tracks and former rights of way that have been used in the past for construction activities, and one suggested use raised is to use those tracks to access the B Reactor in the event it becomes open to the public.

3.18.2.13 Airports

3.18.2.13.1 Regional Airport

The Tri-Cities Airport at Pasco, owned and operated by the Port of Pasco, is a non-hub air carrier facility serving southeastern Washington and northeastern Oregon. Scheduled air service includes Delta, Horizon Air, Skywest and United Express. The regional airport also provides private and charter services, large and small freight service, and serves private and business aircraft. The Federal Aviation Administration (FAA) air traffic control tower and tracking facility provides radar service to several area airports and supports the three runways, including one that is a full instrument landing system. In 2000, the airport boarded 209,434 passengers, transferred more than 2,000,000 pounds of freight, and had 92,487 total aircraft operations.

3.18.2.13.2 Other Local Airports

The following additional small airports are located in the region.

- The Richland Airport (Port of Benton) is a general aviation facility with two paved runways and a localizer instrument system. About eighty-five single and twin-engine aircraft are based here.

- Vista Field, owned and operated by the Port of Kennewick, is a basic utility airport with one paved runway and no instrumentation. This facility is home base for about thirty small aircraft.

- Walla Walla Regional Airport (Port of Walla Walla) is a commercial service facility with three paved runways and instrumentation. This site is home to about 100 small aircraft. Horizon Air provides passenger service. The runways are capable of handling large aircraft, including freight carriers.

- Prosser Airport is a general aviation facility owned by the Port of Benton. There is one paved runway and no instrumentation. Approximately fifteen to twenty small aircraft are based there.

- A privately owned single paved runway, non-instrumented facility, serves the city of Connell. A few single engine aircraft are based at this facility; however, it does not meet FAA criteria for general utility aircraft use.

- Martin Field at College Place is privately owned, but available for public use. The one runway is paved and non-instrumented. Approximately twenty to twenty-five small craft operate from this facility.

- Lower Monumental is a state-owned, gravel-surfaced, emergency airstrip near Kahlotus. The site is not used on a regular basis.

3.18.2.14 Existing Conditions

3.18.2.14.1 Traffic Volumes

Traffic counts on state highways are collected on a regular basis by the WSDOT. Average daily traffic counts are calculated by averaging the daily traffic counts of several days during a typical week. Locations and volumes for the average daily traffic are listed in Table 3.16.

3.18.2.14.2 Level of Service

The LOS was calculated for the state routes that are located within the Monument. Table 3.17 shows that existing average daily traffic on these facilities is far below the maximum volume that would allow the standard of LOS C to be maintained. The existing volumes shown in the table indicate that State Routes 24 and 240 are generally operating at LOS A under existing conditions.

Table 3.16. Existing Characteristics of Area Highways.

Highway	Location	Functional Classification	Number of Lanes	Average Daily Traffic
State Route 240	North of State Route 224	Minor Arterial	2	18,000
	North of Bypass Highway	Minor Arterial	2	9,600
	North of State Route 225	Minor Arterial	2	3,200
	South of State Route 24	Minor Arterial	2	1,500
State Route 24	West of State Route 240	Minor Arterial	2	2,900
	North of State Route 240	Minor Arterial	2	3,500
	South of State Route 243	Minor Arterial	2	3,400
	North of State Route 243	Collector	2	830
	West of Saddle Mountain Road	Collector	2	1,200
	East of Saddle Mountain Road	Collector	2	1,900
	South of State Route 26	Collector	2	3,600
State Route 225	North of I-82	Collector	2	4,600
	South of State Route 240	Collector	2	1,500
State Route 241	South of State Route 24	Collector	2	1,200
State Route 243	West of State Route 24	Minor Arterial	2	3,900
State Route 124	East of US 12	Minor Arterial	2	5,400
I-82	West of State Route 225	Freeway	4	13,000
	East of State Route 224	Freeway	4	16,000
	East of I-182	Freeway	4	6,300
	West of US 395	Freeway	4	8,400
I-182	West of US 395	Freeway	4	32,000
Source: WSDOT 2002				

Table 3.17. Highway Level of Service Assessment.

Highway	Location	Existing Average Daily Traffic[1]	Maximum ADT Maintain LOS C[2]	Estimated LOS[2]
State Route 24	West of State Route 240	2,900	12,000	A
State Route 24	North of State Route 240	3,500	10,000	A
State Route 24	At Vernita Bridge	3,400	12,000	A
State Route 24	East of State Route 243	830	11,000	A
State Route 240	North of State Route 225	3,200	12,000	A
State Route 240	North of I-82	18,000	62,000	A

Notes: [1] Source: Washington State Department of Transportation 2003.
[2] Based on Highway Capacity Manual (TRB 2000) highway LOS procedures.

Table 3.18. Historical Accident Data, 1993 to 1996.

Route	Segment	Length (mi)	Four-year Accident Rate (Accidents Per Million VMT)	County
State Route 240	State Route 24 to Beloit Road	7.95	1.4	Benton
	Beloit Road to State Route 225	12.53	0.8	
	State Route 225 to the Richland City Limits	1.88	2.0	
State Route 24	State Route 241 to State Route 240	7.95	1.0	Benton
	State Route 240 to Priest Rapids Dam Road	3.55	1.4	
	Priest Rapids Dam Road to the Grant County Line	1.53	1.8	
	Grant County Line to State Route 243	0.34	1.1	Grant
	State Route 243 to 24 SW Road	8.81	1.4	
	24 SW Road to the Adams County Line	12.26	0.8	
Source: WSDOT 1997				

3.18.2.14.3 Accidents

Table 3.18 summarizes the most recent accident data that was available from the WSDOT for State Routes 240 and 24 in the area (WSDOT 1997). Accident rates are calculated according to million vehicle miles traveled on the segment. The statewide average calculated for the same time period shown in the table was 1.75 accidents per million miles traveled. The table shows that two locations in the project vicinity have rates slightly higher than the statewide average, and all other rates are below the average.

Field observation of the study area indicated that vehicles tend to travel through the area at fairly high speeds. The relatively low volumes and low number of access points are conducive to higher travel speeds.

3.18.2.15 Future Planned Projects

3.18.2.15.1 Regional Planning Projects

The WSDOT Regional Transportation Planning Organization Planning Project list includes two improvements in the project area.

- State Route 24: Construct climbing lanes for trucks in the Vernita vicinity and improve the State Route 24/240 intersection.

- State Route 240: Widen the road to four lanes from the State Route 225 intersection to Snively Road.

These are identified as future planned projects, but are not included in financially constrained project lists, so they are not anticipated to happen in the near to mid-future. No additional projects were identified on financially constrained or unconstrained state, county, or regional project lists.

3.18.2.15.2 Vernita Rest Area

The WSDOT is planning to renovate the Vernita Rest Area, with design beginning in the spring of 2005. The project will consist of demolition of the existing building, construction of a larger facility, and site improvement and landscaping. The project does not include any expansion of the parking area, nor increase in the overall site footprint. Completion of preliminary engineering is expected in the fall of 2005, with the project going out to bid in summer 2006 and completed in the spring of 2007 (WSDOT 2004).

3.18.3 Utilities

Several federal and local government agencies and commercial businesses operate utilities in the Monument under DOE permits, easements, and rights-of-way agreements. These include the BPA, Energy Northwest, SCBID, Benton County, and various private sector communications businesses.

3.18.3.1 BPA Transmission Lines and Substations

The BPA has existing agreements with the DOE for management of transmission line rights-of-way, access roads, microwave tower lines-of-sight, electric power substations, and other sites. Seventeen high-voltage transmission lines cross the Monument boundaries, with eleven of these crossing the Hanford Reach. Some of the transmission line rights-of-way include fiber-optic lines for rapid response to outages. Two electric substations are located within the Monument boundaries. The BPA also operates several microwave towers within Monument boundaries, with corresponding microwave paths that need to remain clear of structures or vegetation that would obstruct communications signals between the towers.

Periodic patrols and 24-hour access for emergency replacement of failed equipment are required for these facilities. The lines are patrolled by helicopter usually three times each year to assess potential problem areas. In addition, helicopters may be used in lieu of ground vehicles for maintenance or repairs. A complete review of the condition of the rights-of-way and lines is conducted from ground vehicles at least once per year. Regular maintenance to ensure continued power transmission through control of unwanted vegetation, adequate line clearance, and replacement of aging parts is necessary.

The BPA has easements and maintains several roads providing access to its facilities within the Monument. Access road maintenance includes regular grading of the road surface; road repair and reconstruction when needed; maintenance of gates, locks and culverts; and vegetation management.

Vegetation management follows the guidance outlined in the BPA's Transmission System Vegetation Management Program EIS (DOE/EIS-0285). The BPA keeps the rights-of-way clear of brush, timber, dangerous trees, structures and fire hazards, and prevents any use of the area that would interfere in any manner with the BPA's use for transmission line purposes. Options for vegetation management include mechanical removal and herbicide and biological agents. In general, BPA personnel must complete a seven-step process, which includes documentation on a checklist, for each transmission line or facility where vegetation management is being considered to ensure that no sensitive resources or landowner needs are overlooked and unnecessarily impacted. The BPA coordinates with the Monument on proposed activities.

The BPA will likely need to expand its existing transmission system in the vicinity of the Monument to meet future needs for moving electricity from generation sources in Montana, northern Idaho, and northeastern Washington to load centers in the Pacific Northwest. Any activities related to transmission system expansion would first require study and analysis under the NEPA and coordination with the DOE and FWS to ensure protection of the Monument's natural and cultural resources.

3.18.3.2 Energy Northwest

Energy Northwest operates and maintains the Columbia Generating Station, a boiling water nuclear fission reactor located along the south shore of the Columbia River and near the Monument's southeast boundary. Associated facilities within the Monument boundary include underground utilities, an access road, buried pipes for water intake and discharge, and two pump houses. These facilities require regular unimpeded monitoring and maintenance activities. The partially completed WNP-1 and -4 Nuclear Plants are located adjacent to the Monument boundary. These sites have been slated for possible future development as industrial/commercial areas.

Monument lands and waters fall within the ten-mile emergency planning zone for the Columbia Generating Station. Energy Northwest has an exclusion authority in a 1.2-mile radius around the station. There are sirens scattered throughout the Hanford Site and, in particular, placed along the Hanford Reach of the Columbia River approximately one-quarter mile from the south and west bank for evacuation of river recreationists. There is an existing plan for the automatic river closure and evacuation of nearby residential areas in the event of an emergency.

3.18.3.3 Communication Towers and Other Transmission Lines

Rattlesnake Mountain supports seven communications towers operated under DOE easements and leases. These towers provide services for local and regional communication networks and emergency services and for commercial interests. The towers and associated buildings require regular patrol and maintenance.

The Benton County PUD operates and maintains transmission lines on Rattlesnake Mountain under a DOE right-of-way agreement. The power lines and associated access roads require regular inspection and maintenance.

3.18.3.4 South Columbia Basin Irrigation District

The SCBID operates facilities within the Monument that are associated with a major irrigation project which delivers water from the Grand Coulee Dam southward on the Columbia Plateau 125 miles to the confluence of the Snake and Columbia Rivers. Facilities within the Monument include main canals, lateral canals, drains and wasteways, including the WB-10 Ponds and the Saddle Mountain Lakes. These facilities and their access roads require regular monitoring and maintenance activities.

3.18.4 Valid Existing Rights

Chapter 1 provides a discussion of the major valid existing rights. The only issue here is the infrastructure needed to allow for the implementation of those rights. Of the rights identified in Chapter 1, the only real need for infrastructure is for access. All of the rights holders have their own service roads and will maintain them, sometimes in conjunction with the FWS. However, many of these service roads are accessed from FWS-managed Monument roads; these roads are briefly described in Section 3.18.2. All of the roads needed for access for valid rights holders are planned for continued operation by the FWS.

Of course, the valid existing rights holders are maintaining infrastructure of their own, including irrigation canals, power lines, electric substations, etc. Some of those facilities are described under utilities (see Section 3.18.3).

The only other existing use specifically mentioned in the White House Background Paper accompanying the Proclamation is for the movement of a specific livestock herd. "The DOE has issued a license (#R006-94LI12799.000) to the S. Martinez Livestock, Inc., for a road right-of-way to herd livestock across the Monument along what is commonly known as the Wanapum Road. This license is a valid existing right that is protected by the preservation of valid existing rights in the proclamation." This activity does not require any specific infrastructure beyond that of the continued existence of the Wanapum Road, which is planned.

There are a variety of other land use authorizations that were in effect at the time of the Proclamation, and that, although they involve no rights, or their standing as a right remains to be determined, continue into the present. For example, there are a variety of communications facilities in the Monument. There are also state or county gravel storage sites in the Monument. The FWS will need to determine if these are consistent with protection of Monument resources, and the infrastructure needs will be determined/assessed at that time, although it is unlikely there would be any needs beyond the existing roads system.

3.19 Social-Economic Setting

Demographic information obtained from the U.S. Bureau of Census was used to identify the total population near the Monument, as well as its composition. The four counties immediately surrounding the Monument—Adams, Benton, Franklin and Grant—and other counties within a 60-mile radius—Kittitas, Walla Walla and Yakima—are considered the populations most impacted by the Monument and were chosen as the basis for all socioeconomic analysis. Native American tribes that have treaty rights in the Monument are also considered as they exercise those treaty rights.

3.19.1 Population Demographics

This section provides a general overview of the existing population in the region surrounding the Monument. Additional demographic composition can be found below in section 3.19.3.2, where minority and low-income populations are described in order to analyze environmental justice in Chapter 4.

The Monument is located in the counties of Adams, Benton, Franklin and Grant. A perimeter that projects sixty miles in all directions of the Monument includes the counties of Kittitas, Walla Walla and Yakima. These seven counties are considered to comprise the affected demographic and economic region.

3.19.1.1 General Population

Table 3.19 presents population in the state and in the counties that comprise the study area. The table shows that the greatest share of the regional population resides in Benton and Yakima County, and that Benton County has by far the highest population density in the region. A total population of approximately 589,300 people resides in the study area.

Table 3.19. Population in Economic Study Area.

Jurisdiction	Population	State Population (%), County Ranking[1]	Population Density (Persons/Square Mile)
Adams County	16,000	31	8.6
Benton County	140,700	10	83.7
Franklin County	45,900	21	39.7
Grant County	75,900	13	28.4
Kittitas County	34,000	25	14.8
Walla Walla County	54,200	19	42.0
Yakima County	222,600	7	49.0

[1] There are thirty-nine counties in the state of Washington. Source: Washington State Employment Security Department, 2000–2002.

While the largest percentage of residents within the study area considers itself white (497,900 people), the minority population within the area of impact consists of approximately 91,400 people and represents approximately 16% of the population in the assessment area. The ethnic composition of the minority population is primarily of Hispanic origin (approximately 22%), which can be of any race. The Hispanic population varies greatly across the study area, both in total population (from a high of 23,500 in Benton County to a low of 900 in Kittitas County) and in percentage of the population (48% in Adams County to 3% in Kittitas County).

3.19.1.2 Native American Populations Near the Monument

Substantial Native American populations are located within the 60-mile assessment area (approximately 13,000 people). Census block groups within the assessment area and composed primarily of Native American populations are primarily located on the Yakama Indian Reservation in Yakima County, Washington. However, other Native American populations

located outside of the assessment area also have an interest in the Monument based on treaty rights.

3.19.2 Government-to-Government Consultations with Native American Tribes—Partial History

The FWS, mainly through the Monument, has consulted with the four federally recognized Native American Tribes in the area—Yakama Nation, Nez Perce Tribe, CTUIR and CCT—and the Wanapum. The consultation has been through numerous methods, including mail and email correspondence, telephone conversations, and in-person meetings and presentations. Consultation over management of FWS managed lands commenced in April 1999 with the CTUIR, in June 1999 with the Nez Perce Tribe, and in July 1999 with the Yakama Nation.

The Presidential Proclamation formally designated the Monument in June of 2000. In 2001, the FWS began consultation specifically on the CCP with the Yakama Nation, CTUIR, and Nez Perce Tribe, primarily through written communication and in-person meetings (Nez Perce Tribe and CTUIR). In 2002, FWS staff met with Yakama Nation, CCT, and CTUIR tribal representatives and provided written communication with all of the tribes to describe the CCP process and invite consultation on the cultural and natural resources of the Monument. A Planning Workshop was held November 4–7, 2002, with subsequent two workshops held February 10–13 and June 17–19, 2003.

In April 2003, the FWS met with the Nez Perce Tribe's Natural Resources Subcommittee, and in May 2003, FWS staff met with the CTUIR's Cultural Resources Committee. In July 2003, the FWS invited all tribes to attend a land and river tour of the Monument. Tribal representatives from the Yakama Nation, Nez Perce Tribe, CTUIR, and Wanapum attended. In October, the Monument's Project Leader and Cultural Resources Manager met with the Colville Reservation's Natural Resources Committee and Business Council.

Since January 2004, Monument and other FWS staff have met with the CTUIR, Yakama Nation, and Nez Perce Tribe numerous times, primarily to discuss draft CCP goals, objectives and alternatives and to provide updates on the CCP's development.

3.19.3 Environmental Justice Setting

On February 11, 1994, President Clinton signed Executive Order 12898, requiring federal agencies that administer and implement programs, policies and activities that affect human health or the environment to identify and avoid "disproportionately high and adverse" effects on minority and low-income populations. (See "Demographics" below.)

The FWS's environmental justice guidelines state that environmental justice is one of the factors considered when developing an environmental analysis. These guidelines stipulate that environmental justice should be addressed similar to other environmental concerns and should include identification, avoidance, minimization and finally, mitigation. To correctly identify potential inequities, the environmental justice analysis requires preliminary census research and may require more detailed studies of communities/populations in combination with effective community outreach. This process is intended to ensure that projects are developed in a manner that avoids disproportionately high and adverse effects on minority and low-income populations.

The FWS is required to undertake activities in support of the Environmental Justice Program and ensure compliance with Executive Order 12898 in all FWS programs and activities. Incorporation of environmental justice principles is an implementation of the NEPA, Title VI of the Civil Rights Act, Uniform Relocation Act, and other regulations and guidance that affect social, economic and environmental factors; public health; and public involvement.

3.19.3.1 Area of Consideration

Data for five communities—Richland, Pasco, Mattawa, Othello and Prosser—and three counties—Benton, Franklin and Grant—in the state of Washington were evaluated as part of this environmental justice analysis. The communities were chosen due to their proximity to the Monument and for their differing social and economic backgrounds. The counties are those in which the Monument is primarily located. Following is a discussion of minority—including Native American populations—and low-income data for these communities and counties.

3.19.3.2 Minority and Low-Income Populations

A minority is defined as a person who has any of the following traits.

- Black (having origins in any of the black racial groups of Africa).
- Asian (having origins in any of the original peoples of the Far East, Southeast Asia, the Indian subcontinent, or the Pacific Islands).
- Native American and Alaskan Native (having origins in any of the original people of North America and who maintains cultural identification through tribal affiliation or community recognition).

- Hispanic (of Mexican, Puerto Rican, Cuban, Central or South American, or other Spanish culture or origin, regardless of race).[93]

Detailed minority data for the five communities, three counties, and the state of Washington are included in Tables 3.20 and 3.21. The distribution of races in the five communities is compared to the state of Washington in Table 3.20 below.[94] The distribution of races in the counties is compared to the state of Washington in Table 3.21. In 2000, Washington State's minority population was 18.2%, higher than the community of Richland (10%), but lower than in the communities of Mattawa (97%), Pasco (47%), Othello (46%) and Prosser (20%). In 2000, Franklin and Grant Counties had higher minority populations (38.1% and 23.5%) than the state of Washington (18.2%); Benton County's minority population (13.8%) was lower than the state's minority population.

3.19.3.2.1 Hispanic and Latino Populations

As explained in footnote 1, Hispanics may identify with any race and are counted according to their answers on the 2000 census. However, the Census Bureau asked respondents to provide an Hispanic origin response, as well as responding to the question of racial origin. As such, the Census Bureau was able to identify the Hispanic/Latino population. The Hispanic or Latino populations in the sample communities, surrounding counties, and state of Washington are:

- Adams County—7,732 (47.1%).
- Benton County—17,806 (12.5%).
- Franklin County—23,032 (46.7%).
- Grant County—22,476 (30.1%).
- Mattawa—2,343 (89.8%).
- Othello—3,728 (63.8%).
- Pasco—18,041 (56.3%).
- Prosser—1,421 (29.4%).
- Richland—1,826 (4.7%).
- Washington—441,509 (7.5%).

[93] Origin can be viewed as the heritage, nationality group, lineage, or country of birth of the person or the person's parents or ancestors before their arrival in the United States. As such, people who identify their origin as Spanish, Hispanic, or Latino may be of any race. According to the U.S. Census Bureau (Census Bureau): The data on the Hispanic or Latino population were derived from answers to a question that was asked of all people. The terms "Spanish," "Hispanic Origin," and "Latino" are used interchangeably. Some respondents identify with all three terms, while others may identify with only one of these three specific terms. People who identify with the terms "Spanish," "Hispanic," or "Latino" are those who classify themselves in one of the specific Spanish, Hispanic, or Latino categories listed on the [census] questionnaire—Mexican, Mexican American, Chicano, Puerto Rican, or Cuban—as well as those who indicate that they are "Other Spanish/Hispanic/Latino." Hispanics or Latinos who do not identify with one of the specific origins listed on the questionnaire but indicated that they are "Other Spanish/Hispanic/Latino" are those whose origins are from Spain, the Spanish-speaking countries of Central or South America, the Dominican Republic, or people identifying themselves generally as Spanish, Spanish-American, Hispanic, Hispano, Latino, and so on.

[94] The category of "two or more races" in the 2000 census data addresses the issue of avoiding double-counting individuals who might be of two different races (e.g., Hispanic and Native American).

Table 3.20. Race Distribution in Five Sample Communities Near the Monument and the State of Washington, 2000.

Race	Representative Communities					
	Richland	Pasco	Mattawa	Othello	Prosser	State
White	34,662 (89.5%)	16,919 (52.8%)	772 (29.6%)	3,168 (54.2%)	3,865 (79.9%)	4,821,823 (81.8%)
Black or African American	530 (1.4%)	1,033 (3.2%)	5 (0.2%)	31 (0.5%)	26 (0.5%)	190,267 (3.2%)
Native American and Alaska Native	293 (0.8%)	248 (0.8%)	14 (0.5%)	59 (1.0%)	44 (0.9%)	93,301 (1.6%)
Asian	1,571 (4.1%)	567 (1.8%)	24 (0.9%)	59 (1.0%)	37 (0.8%)	322,335 (5.5%)
Native Hawaiian/ Other Pacific Islander	41 (0.1%)	46 (0.1%)	0 (0.0%)	5 (0.1%)	14 (0.3%)	23,953 (0.4%)
Other Single Race	718 (1.9%)	12,004 (37.4%)	1,718 (65.8%)	2,312 (39.5%)	731 (15.1%)	228,923 (3.9%)
Two or More Races	893 (2.3%)	1,249 (3.9%)	76 (2.9%)	213 (3.6%)	121 (2.5%)	213,519 (3.6%)
Total Population	38,708	32,066	2,609	5,847	4,838	5,894,121

Notes: Percentages may not exactly equal 100 due to rounding. Source: U.S. Census Bureau 2000.

Except for Richland, all the sample communities and surrounding counties have Hispanic populations well above the Washington State average, as a percentage of the population. This is a prevalent minority population in the area around the Monument and must be considered in development and implementation of the CCP. To date, there has been no special outreach to Hispanic populations, although the FWS has tried to facilitate their involvement in the CCP process by having Spanish translation available for scoping meetings. The FWS has been producing Spanish language versions of some signs and informational publications. Additional outreach, more Spanish language signs, and other measures to facilitate the involvement of Hispanic populations in the Monument will occur with implementation of the CCP, regardless of the alternative chosen.

3.19.3.2.2 Native American Populations

The Yakama Indian Reservation, located in Klickitat and Yakima Counties, Washington, is approximately fifty miles to the west of the Monument. As noted elsewhere, the Monument and the entire Hanford Site has cultural significance to the members of the CCT, CTUIR, Nez Perce Tribe, Wanapum and Yakama Nation. The FWS is keenly aware and highly supportive of tribal interest in the Monument and has made every effort—within the CCP development time frame—to involve, listen to, and accommodate area tribes and Native American peoples.

Table 3.21. Race Distribution in Counties Around the Monument and Washington State, 2000.

Race	Surrounding Counties				
	Adams	Benton	Franklin	Grant	Washington
White	10,672 (65.0%)	122,879 (86.2%)	30,553 (61.9%)	57,174 (76.5%)	4,821,823 (81.8%)
Black or African American	46 (0.3%)	1,319 (0.9%)	1,230 (2.5%)	742 (1.0%)	190,267 (3.2%)
Native American and Alaska Native	112 (0.7%)	1,165 (0.8%)	362 (0.7%)	863 (1.2%)	93,301 (1.6%)
Asian	99 (0.6%)	3,134 (2.2%)	800 (1.6%)	652 (0.9%)	322,335 (5.5%)
Native Hawaiian/Other Pacific Islander	6 (0.0%)	163 (0.1%)	57 (0.1%)	53 (0.1%)	23,953 (0.4%)
Other Single Race	5,042 (30.7%)	9,983 (7.0%)	14,300 (29.0%)	12,967 (17.4%)	228,923 (3.9%)
Two or More Races	451 (2.7%)	3,829 (2.7%)	2,045 (4.1%)	2,247 (3.0%)	213,519 (3.6%)
Total Population	16,428	142,475	49,347	74,698	5,894,121

Notes: Percentages may not exactly equal 100 due to rounding. Source: U.S. Census Bureau 2000.

Future opportunities of tribal members to exercise treaty rights are dependent upon the health of the ecosystems. The tribes assert that a treaty right to hunt, fish, or gather plants is diminished (if not voided) if the fish, wildlife, or plants have vanished or are contaminated to the extent that they threaten human health. These resources, particularly the resources with cultural and religious connotations, do not have equivalent value for the general population. Treaty reserved tribal fishing rights have been recognized as being effective within the Hanford Reach. The tribes also have an interest in continuing/renewing traditional uses, such as gathering of foods and medicines, hunting, and pasturing horses and cattle on Monument lands.

3.19.3.2.3 Low Income Populations

The Census Bureau follows the Office of Management and Budget's Statistical Policy Directive 14 to determine poverty status based on income level. To determine poverty, the Census Bureau uses a set of monetary income thresholds that vary by family size and composition. If the total income for a family or unrelated individual falls below the relevant poverty threshold, then the family or unrelated individual is classified as being below the poverty level. Poverty status can be used as a measure of low income for environmental justice analyses. Poverty thresholds do not vary geographically, but do vary according to size of family unit.

In 1999, 7.3% of the population of Washington consisted of families with incomes below the poverty level; Table 3.22 analyzes poverty around the Monument. With the exception of

Richland, all of the jurisdictions looked at have a higher percentage of their families at or below the poverty level than the state average. Also, all communities except Richland have median family income lower than that of Washington.[95] All of the counties except Benton have poverty rates equal to or higher than the state of Washington; Adams, Franklin and Grant Counties had median incomes lower than that of Washington.[96] There may be a correlation between lower incomes and higher minority populations, factors for which are beyond the scope of this CCP.

Table 3.22. Low Income Statistics for Area Surrounding the Monument.

Community	Median Household Income	Median Family Income	Population Below Poverty Level	Families Below Poverty Level
Adams County	$33,888	$37,057	18.2%	13.6%
Benton County	$47,044	$54,146	10.3%	7.8%
Franklin County	$38,991	$41,967	19.2%	15.5%
Grant County	$35,276	$38,938	17.4%	13.1%
Mattawa	$31,964	$25,921	34.4%	30.6%
Othello	$30,291	$31,282	24.0%	18.4%
Pasco	$34,540	$37,342	23.3%	19.5%
Prosser	$39,185	$45,162	13.5%	11.5%
Richland	$53,092	$61,482	8.2%	5.7%
Washington	$45,776	$53,760	10.6%	7.3%
Source: U.S. Census Bureau				

Open areas (e.g., parks, national forests) are often of great importance to low-income families as a source of recreation and entertainment. It is important to keep public fees associated with access and use of these resources low in order to accommodate use by low-income families, a factor that will be considered by the FWS in selection of a preferred management alternative and its implementation.

3.19.4 Fiscal Environment

The fiscal environment is described by the industrial makeup, employment levels, and average wages in the area.

[95] The state of Washington's median income for families was $53,760.

[96] Richland, in Benton County, helps to raise the county's average income and lower its percentage of families below the poverty line.

3.19.4.1 Industrial Makeup

One way to measure the industrial makeup of an area, and thereby its relative economic strength, is to compare it to other areas. In the state of Washington, location quotients are calculated for the major industrial sectors using employment data. The idea of the location quotient is to compare a given industry's share of total local employment versus its share statewide. Dividing the statewide industry employment share into the local industry share derives the quotient. Therefore, a quotient of 1.0 denotes an industry in which the local area is typical to the state as a whole. A value greater than 1.0 indicates an industry with higher concentration of employment than in the state as a whole, and a value less than 1.0 indicates the industry has a lower employment concentration than the state as a whole. Table 3.23 presents location quotients for major industrial sectors in the counties that comprise the economic study area.

Table 3.23. Location Quotients in Economic Study Area.

Industrial Sector	Adams	Benton	Franklin	Grant	Kittitas	Walla Walla	Yakima
Agriculture	9.0	2.8	7.2	6.8	2.0	3.4	6.3
Government	1.3	0.9	1.1	1.2	1.9	1.2	0.9
Manufacturing	1.2	0.6	0.5	2.8	0.5	1.3	1.0
Trade	1.3	0.3	1.2	0.8	1.2	0.8	1.3
Construction/Mining	0.4	0.8	0.9	1.5	0.7	0.5	0.5
Transportation & Utilities	0.7	2.6	0.8	0.6	0.7	N/A	0.5
Services	0.4	1.0	0.8	0.5	0.7	0.9	0.8
Fire, Insurance, Real Estate	0.2	0.6	0.3	0.3	N/A	0.7	0.5

N/A = information not available.
Source: Washington State Employment Security Department, 2000–2002

The table shows that agriculture is the strongest sector in the region and that government employment is also stronger in the region than the statewide average. Manufacturing and trade quotients vary from county to county, with some counties in the region stronger than the statewide figures and some not. The other major industrial sectors are generally shown to be weaker in the region.

3.19.4.2 Unemployment

The unemployment rate is the percentage of the total labor force that has been unable to secure jobs but is actively looking. Table 3.24 summarizes the average unemployment in the counties in the economic study area. The table shows that most of the counties have average

unemployment that exceeds the state average, and for many of the counties the difference is substantial.

Table 3.24. Average Unemployment in Economic Study Area.

Jurisdiction	Average Unemployment Rate (%)
Adams County	9.4
Benton County	6.2
Franklin County	9.0
Grant County	9.5
Kittitas County	5.3
Walla Walla County	5.8
Yakima County	9.1
State of Washington	4.7
Source: Washington State Employment Security Department, December 2005	

3.19.4.3 Average Wages

Annual average covered wages are derived by dividing the total wages paid in an area by the annual average employment in that area. The number reflects actual wages and does not include benefits such as insurance or retirement plans. Jobs not covered by the unemployment insurance program are not covered. However, the program does cover approximately 85% of all employment in the state. Table 3.25 summarizes the average annual wages for the counties within the economic study area.

Table 3.25. Average Wages in Economic Study Area

Jurisdiction	Average Wage In 2000
Adams County	$23,900
Benton County	$32,700
Franklin County	$21,700
Grant County	$24,000
Kittitas County	$22,400
Walla Walla County	$25,300
Yakima County	$23,300
State of Washington	$35,400
Source: Washington State Employment Security Department 2002	

The table shows that all counties within the study area have average wages lower than the statewide average. However, it is important to note that only two counties within the state (King County and San Juan County) have average wages higher than the statewide average. The table also shows that the average wage in Benton County is considerably higher than the wages of other counties in the region. This is primarily caused by the substantial concentration of high-paying jobs related to Hanford Site operations in Benton County and the high concentration of lower-paying agricultural jobs in the other counties.

3.19.4.4 Economic Development Organizations

This section lists the economic development organizations that have been identified in each county in the study area.

3.19.4.4.1 Adams County

Adams County Economic Development Council: This is a private, non-profit organization with both private and public sector employees. A primary emphasis of the council is to find ways to add dollar value to local products prior to shipment, promoting sustainable growth that melds with the established culture of the region.

Chambers of Commerce: Othello, Lind, and Ritzville each have a Chamber of Commerce, composed of local business owners and other interested individuals who work together to further the business interests of their respective communities.

3.19.4.4.2 Benton and Franklin Counties

Tri-City Industrial Development Council (TRIDEC): TRIDEC was created in 1962 to achieve stability and balanced growth through job creation and retention, as well as enhance of the quality of life. A thirty-nine-member board of directors governs TRIDEC. Its mission is pursued through proactive business recruitment, retention and expansion.

3.19.4.4.3 Grant County

Grant County Economic Development Council (GCEDC): The GCEDC is a private, non-profit corporation funded by both private and public sectors. The primary mission of the GCEDC is to work closely with existing industries to assist with business retention and expansion.

Economic Development Task Forces: Moses Lake, Ephrata and Grand Coulee have active economic development task forces working to further the business interests of their respective communities.

3.19.4.4.4 Kittitas County

Phoenix Economic Development Group: Appointed by the Kittitas County Commissioners, this group is a cooperative public/private nonprofit association established to provide leadership that stimulates business development and promotes economic opportunities in the county.

Chambers of Commerce: Ellensburg, Cle Elum/Roslyn, and Northern Kittitas County/Roslyn each has a Chamber of Commerce, composed of local business owners and other interested individuals who work together to further the business interests of their respective communities.

3.19.4.4.5 Walla Walla County

Port of Walla Walla: This is a municipal corporation established by voters in 1952 to expand the economic base in the county. It is the principal local contact for state agencies involved in economic development efforts.

Walla Walla Valley Chamber of Commerce: A private, non-profit organization made up primarily of business and community leaders, the organization is committed to furthering the business interests of the greater Walla Walla area.

Walla Walla Downtown Foundation: Comprised primarily of downtown businesses and local government representatives, this organization is committed revitalizing the downtown Walla Walla area.

3.19.4.4.6 Yakima County

Yakima County Development Association: This is an organization whose mission is to enhance the quality of life and economic stability of the Yakima region by retaining, expanding and recruiting new business and industry.

Chambers of Commerce: Yakima, Toppenish, Grandview, Sunnyside, Granger, Selah and Zilah each have a Chamber of Commerce, composed of local business owners and other interested individuals who work together to further the business interests of their respective communities.

3.19.4.5 Recreational Use at the Monument

The primary impact of the Monument on the local economy will be through tourism and recreational use of the Monument. Table 3.26 summarizes the estimated annual recreational use in the Monument under existing conditions.

Table 3.26. Existing Annual Estimates of Recreational Users.

Activity	Estimated Annual Visitor Days (2004)
Hunting: Big Game	200
Hunting: Upland Game	400
Hunting: Waterfowl	1,000
Fishing	20,000
Wildlife Observation	500
Wildlife Photography	70
Education & Interpretation	250
Hiking	330
Non-Motorized Boating	670
Motorized Boating	2,000
Commercial River Trips	1,880
Equestrian Use	330
Driving For Pleasure	330
Other	1,870
Total	29,830

3.19.5 Educational Services

The area around the Monument offers a fairly diverse array of opportunities for pursuing an education, including public and private schools, colleges and community education.

3.19.5.1 Public Schools

Primary and secondary education are served by the Tri-Cities, Kiona-Benton, Othello, North Franklin, and Wahluke School Districts. The combined 2004 enrollment for all districts was 43,702 students.

Table 3.27. Public Schools Near the Monument.

School District	Elementary	Middle	Jr.	High	Alternative[1]
Columbia	1	1		1	1
Finley	1	1		1	
Kennewick	14	4		3	6
Kiona-Benton City	1	4		1	1
North Franklin	3		1	2	2
Othello	3		1	1	
Pasco	10	3		2	2
Richland	8	3		3	2
Wahluke	1	3		1	1
Total	40	17	2	13	14

Note: [1] Includes all non-traditional schools—vocational centers, special education, etc.

Table 3.28. Enrollment in Area Public School Districts.

School District	Enrollment	Asian	Native American	Black	Hispanic	White
Columbia	968	.72% (7)	1.45% (14)	.72% (7)	19.32% (187)	77.69% (752)
Finley	1,030	.58% (6)	1.17% (12)	.29% (3)	17.57% (181)	80.39% (828)
Kennewick	14,987	2.02% (303)	0.55% (82)	2.32% (348)	22.24% (3,333)	72.88% (10,922)
Kiona-Benton City	1,656	1.27% (21)	0.60% (10)	0.91% (15)	20.65% (342)	76.57% (1,268)
North Franklin	1,942	1.49% (29)	0.31% (6)	0.51% (10)	58.75% (1,141)	38.93% (756)
Othello	3,096	0.48% (15)	0.19% (6)	0.48% (15)	74.48% (2,306)	24.35% (754)
Pasco	10,477	1.47% (154)	0.46% (48)	2.80% (293)	67.68% (7,091)	27.59% (2,891)
Richland	9,790	4.50% (441)	0.83% (81)	2.69% (263)	6.05% (592)	85.93% (8,413)
Wahluke	1,754	0.40% (7)	0.74% (13)	0.00% (0)	86.32% (1,514)	12.54% (220)
Total	43,702	2.22% (970)	0.56% (246)	2.16% (944)	37.34% (16,319)	57.72% (25,224)

Notes: Actual student numbers are approximations based on the percentages provided by the Washington State Office of Superintendent of Public Education.
Source: Washington State Office of Superintendent of Public Education 2004 Report Card

3.19.5.2 Private Schools

Several private elementary and secondary schools offer an alternative to the local public school system. These institutions include Country Haven Academy, Kingspoint Christian, St. Patrick's, Tri-Cities Prep, and Tri-City Junior Academy in Pasco; Bethlehem Lutheran, Calvary Christian, Shepherd's Academy, and St. Joseph's in Kennewick; and Children's Garden Montessori, Christ the King, Liberty Christian, and Oasis in Richland; and Liberty Bell Academy and Mid-Columbia Christian in Othello.

3.19.5.3 Post-Secondary Education

Post-secondary education in the area is provided by a junior college, Columbia Basin College, and the Tri-Cities branch campus of Washington State University.

3.19.5.3.1 Columbia Basin College

Columbia Basin College is a comprehensive two-year college that provides quality education and effective job preparation. It offers approximately 7,000 students a full array of Associate Degree and Vocational/Technical career programs. The college works closely with regional employers to develop specific programs needed to train prospective workers for area businesses. The Workforce Training Center houses 120 computer work stations and provides state-of-the-art training customized to an employer's needs. Columbia Basin College exists to ensure that the people of Benton and Franklin Counties have access to educational programs providing sufficient knowledge for higher educational achievement, meaningful employment, basic skills development, cultural enrichment, and physical and emotional well being.

3.19.5.3.2 Washington State University

Washington State University's Tri-Cities branch campus provides its 1,300 students the opportunity to acquire undergraduate and graduate degrees in a variety of programs. The Tri-Cities campus is the gateway to Washington State University (WSU), a premier research university, centered in Pullman, Washington. The branch campus, established in 1989, provides upper-division undergraduate and graduate study opportunities, research and public service to the community. The Consolidated Information Center (CIC) houses the merged Washington State University Tri-Cities Library, operated by the university, and the Hanford Technical Library, operated by the PNNL under contract with the DOE. It also houses the DOE Public Reading Room, Business LINKS, classrooms and exhibit space. The CIC assists in Hanford Site remediation by providing easy access to WSU and Hanford Technical Library resources. Its training facility has state-of-the-art telecommunications capabilities. In addition, Business

LINKS provides the region with a comprehensive business and entrepreneurial marketing, training and referral service. The Food and Environmental Quality Laboratory and the Washington State Pest Management Resource Service provide facilities for scientists to conduct research on herbicides, pesticides and agricultural pests.

3.19.6 Agriculture

While Benton County, and to a lesser extent Franklin County, relies heavily on government and the Hanford Site cleanup as an economic base (total expenditures), the other counties in the sixty-mile radius study area are much more dependent on agriculture for total revenues.[97] The following data is taken from the Washington State Employment Security Department reports for 2002 and reflects 2000 data.

3.19.6.1 Adams County

In Adams County, agriculture is the number one industrial employer; 28% of workers in Adams County are employed by the agricultural sector. Wheat is the premiere crop in the county, with the fourth highest county production in the state. However, dryland wheat farming required little human labor, employing less than thirty workers. Apples, potatoes and cherries are the most important crops for employment, employing 2,237, 644, and 281 workers, respectively.

3.19.6.2 Benton County

While a large amount of revenues in Benton County come from the Hanford Site, agriculture is an important employer—9% of jobs are related to agriculture. Fruit trees are the most important crop, accounting for 36% of agricultural jobs (1,962 jobs), but the county also produces other fruits (grapes, melons, nectarines and plums), field crops, and vegetables. In fact, grape production is the fastest growing sector (147% increase in jobs to 859).

3.19.6.3 Franklin County

Agriculture in Franklin County accounts for 23% of agricultural jobs in the county. Like Benton County, fruit trees represent the highest employment crop in Franklin County—40% of jobs (1,967 jobs). Franklin County was ranked first in the state for potato, asparagus and sweet corn

[97] Agriculture accounts for 22% of all jobs in the entire state.

production; third for acres of grapes and peaches; and seventh for acres of orchards. The production of vegetables is the second largest employer at 641 workers.

3.19.6.4 Grant County

Grant County, like Adams County, relies on agriculture as its number one employment industry; 23% of workers in Grant County are employed by the farm sector. Grant County also has a substantial wheat harvest (fifth highest, statewide), but fruit trees (apples, cherries, apricots, pears, peaches, nectarines and plums) and potatoes are the most important crops. Fruit trees employed 3,217 workers, while potatoes, where Grant County leads the state in production, employed an estimated 2,000 workers. Ornamental nurseries also employed 500 workers.

3.19.6.5 Kittitas County

In Kittitas County, 6.9% of jobs are related to agriculture. While the county has a large number of beef and dairy cattle farms, which typically pay higher wages, the largest employer is in the production of fruit trees. Oats, hay and potatoes are also important; Kittitas County is the largest producer of oats and hay in the state. These four crops employed 635 people.

3.19.6.6 Walla Walla County

In Walla Walla County, agricultural jobs account for 12% of total employment. The county's primary crop is wheat, although as noted earlier, this crop does not employ many workers, instead being capital intensive. Fruit production is the largest employer, employing 1,468 workers for a total payroll of $20.4 million (out of a total agricultural payroll of $39.2 million). Apples and grapes are the main fruits grown, apples being the more important. Walla Walla County ranks first in the state in production of onions and alfalfa seed and fourth in the state in the production of wheat. Other major crops include corn for grain, sweet corn, potatoes, fruits, and hay.

3.19.6.7 Yakima County

Agriculture in Yakima County accounts for 21% of all jobs. While a breakdown of jobs per crop is not available, 79% of all agricultural jobs (15,720 jobs) were in the production of crops, such as fruit trees (apples, cherries and grapes being the primary crops), hay, carrots, asparagus, mint and grass seed. Of special note is Yakima County's contribution to the nation's alcohol market. Yakima County is home to numerous award-winning wineries, and the Yakima Valley and

Rattlesnake Hills Wine Tours are becoming quite well known among wine connoisseurs. Yakima County also produces a large percentage of the hops used in beer production, both nationally and internationally. These hops are known for their excellent quality and wide variety.

3.19.7 Emergency Services

The Monument and its surrounding area has a high per capita share of law enforcement and firefighting personnel and equipment, as well as a host of emergency notification systems. These resources are briefly described in the sections that follow. See Section 3.20.10, "Hanford Site Protective Safety Buffer Zones," for additional information.

3.19.7.1 Police

Police protection for the Hanford Site is provided by the Hanford Patrol, which is operated by DOE contractors and supported by county sheriff departments, local municipal police departments, and the Washington State Patrol headquartered in Kennewick.

Police protection in Benton and Franklin Counties is provided by county sheriff departments, local municipal police departments, and the Washington State Patrol headquartered in Kennewick. Table 3.29 shows the number of commissioned officers and patrol cars in each department. The Kennewick, Richland and Pasco departments maintain the largest staffs of commissioned officers with seventy-three, fifty and forty-four, respectively.

Table 3.29. Police Personnel in the Tri-Cities.

Area	Commissioned Officers	Reserve Officers	Patrol Cars
Kennewick Municipal	73	15	45
Pasco Municipal	44	33	15
Richland Municipal	50	13	13
West Richland Municipal	12	10	11
Benton County Sheriff	47	15	55
Franklin County Sheriff	19	17	22

3.19.7.2 Monument Law Enforcement

The FWS law enforcement officers perform police protection and enforcement services in the Monument. Currently, the Monument has one law enforcement officer directly assigned to the

Monument (vacant) and one zone (i.e., regional) officer. The nearby Columbia and Mid-Columbia National Wildlife Refuges each have one law enforcement officer who can be called on for assistance. In addition, Mid-Columbia has four collateral-duty officers who can be called on when needed.

Unlike the fire department (see below), Monument law enforcement currently have no mutual-aid agreements with local police departments, but does receive assistance from county sheriffs and the Hanford Patrol. Likewise, Monument personnel provide assistance to Hanford Patrol, Washington State Patrol, WDFW officers, county sheriffs, and city law enforcement.

3.19.7.3 Area Fire Fighting

Fire protection for the Hanford Site is provided by the Hanford Fire Department, which, like the Hanford Patrol, is operated by Hanford Site contractors. The Hanford Fire Department has ninety-three firefighters who are trained to dispose of hazardous waste and to fight chemical fires, in addition to their regular firefighting duties. During a twenty-four-hour duty period, the 1100 and 300 Areas have seven firefighters; the 200 East and 200 West Areas have eight firefighters; the 100 Areas have five firefighters; and the 400 Area, which includes Energy Northwest, has six firefighters. To perform their responsibilities, each station has access to a hazardous material response vehicle equipped with chemical fire-extinguishing equipment, an attack truck that carries foam and Purple-K dry chemical, a mobile air truck that provides air for respirators, and a transport tanker that supplies water to six brushfire trucks. The Hanford Fire Department owns five ambulances and maintains contact with local hospitals.

In addition to the Hanford Fire Department, the FWS has its own firefighting staff and equipment (described below), and the FWS can be assisted by numerous area fire districts. Table 3.30 indicates the number of firefighting personnel, both paid and unpaid, on the staffs of fire districts in the area.

Table 3.30. Fire Protection in the Tri-Cities.

Station	Personnel	Volunteers	Total	Service Area
Kennewick	63	0	63	City of Kennewick
Pasco	30	0	30	City of Pasco
Richland	48	0	48	City of Richland
Benton County Rural Fire Department 1	9	94	103	Kennewick Area
Benton County Rural Fire Department 2	3	37	40	Benton City
Benton County Rural Fire Department 4	5	30	35	West Richland

3.19.7.4 Monument/FWS Firefighting Capacity

Fully staffed, the FWS would have fifteen full-time and nine temporary (seasonal) firefighting staff within the area, all of whom managed by the Mid-Columbia National Wildlife Refuge. Additionally, ten to fifteen refuge staff have completed basic firefighting training and serve as collateral firefighters.

FWS fire staff primarily perform fuels management, fuels hazard reduction, wildland fire suppression, and prescribed fire activities on lands administered by the FWS. The FWS fire team relies on mutual-aid and cooperative working agreements with ten county rural fire protection districts and the Hanford Fire Department for initial and extended attack of fires. Likewise, through these agreements, fire protection services are provided for off-refuge lands as resources and fire protection staffing levels will allow. The mutual aid agreements provide for the first twelve hours of services at no charge to the requesting department.

3.19.7.5 Other Emergency Systems

The Hanford Site Emergency Alerting System was established to provide notification to all site workers (including the Monument) of public health and safety issues that require immediate response. Generally, this system is centered around radiological concerns, but it could also be used to notify site workers of imminent law enforcement and fire concerns. This system uses crash alarm telephones, sirens and an AM radio station; however, the system is outdated and out of compliance. A new system is being developed that will integrate the old system with new technologies not in the current system. Pagers, cell phones, all local area networks, and two-way radios are some of the new technologies that will be directly connected to the new system.

Energy Northwest, as a working nuclear power-production reactor, is required to have a siren warning system to alert personnel and other nearby people in the event of an emergency. Its warning sirens must reach each area where there are people at a minimum decibel level. Under some of the alternatives currently being considered (i.e., allowing for use in the Hanford Dune Field), new or additional sirens would have to be installed.

3.20 Special Area Designations

As noted throughout this CCP, the Monument is a unique and special place. This has led to the creation of several additional actual or potential designations or management overlays, including those resulting from the existence of the Hanford Nuclear Reservation. These overlays include an IBA, an RNA, National Register Historic Districts, Washington Heritage Sites, eligible TCPs,

a potential National Historic Site (B Reactor), and a river corridor eligible and suitable for designation into the NWSRS (see Map 21). Also addressed as per FWS policy are potential wilderness areas.

3.20.1 Important Bird Area

The IBA program is a global effort to identify areas that are crucial for maintaining bird populations. An IBA is a site that provides essential habitat for one or more species of birds. IBAs represent discrete sites, both aquatic and terrestrial, that are critically important to birds during their annual life cycle (i.e., breeding, wintering, feeding, and migration). When the sites are identified, conservation efforts can focus on protecting those sites.

The IBA selection process examines sites based on two characteristics: 1) the presence and abundance of birds; and 2) the condition and quality of habitat. IBAs are chosen using standard biological criteria and the expert review of ornithologists. All sites nominated as potential IBAs are rigorously evaluated to determine whether they meet the necessary qualifications.

Within the United States, the program has been promoted and maintained by the American Bird Conservancy (ABC) and National Audubon Society NAS). The ABC coordinates the identification of nationally significant IBAs, while the NAS works to identify sites in individual states. The NAS, as the Partner Designate for Bird Life International, is working within each state to identify a network of sites across the country that provide critical habitat for birds. By working through partnerships, principally the North American Bird Conservation Initiative, to identify those places that are critical to birds during some part of their life cycle, the hope is to minimize the effects that habitat loss and degradation have on bird populations. In the United States, the IBA program has become a key component of many bird conservation efforts. Additional information can be found at www.audubon.org/bird/iba/.

In Washington State, the goals of the IBA program are twofold: 1) identify the sites in the state most essential for long-term conservation of birds; and 2) take action to ensure the conservation of those sites.

The ALE is a designated IBA. It was chosen because of its unique habitat features and because it is one of the few large, contiguous blocks of shrub-steppe habitat in the Northwest still retaining a dominant pre-European settlement ecology and physical character. The ALE also supports an extraordinary assemblage of breeding birds associated with grassland and shrub-steppe ecosystems, including ferruginous hawks, long-billed curlews, burrowing owls, loggerhead shrikes, sage thrashers, sage sparrows, Brewer's sparrows, and grasshopper sparrows. Two year-round desert springs support extensive riparian areas that provide breeding habitat for flycatchers, warblers, orioles and other neotropical migrants.

The Hanford Reach corridor is also a designated IBA. It comprises the Columbia River and the near-shore environment and extends approximately 0.25 mile inland from the river between the Vernita Bridge and the Ringold Fish Hatchery. The majority of this stretch of river contains specialized habitats, including islands, gravel bars, and rapids, not found elsewhere along the Columbia. This last free-flowing section of one of the largest rivers in the United States is important for birds that use riverine habitats in the arid West. It supports a high concentration of wintering bald eagles and waterfowl. Cliffs provide nesting sites for swallows, owls, hawks and falcons. The forty-plus species of fish inhabiting the Hanford Reach support American white pelicans, gulls, terns and cormorants. Waterbirds, such as herons and egrets, have well-established rookeries in several locations along the river. The riparian habitat within this IBA is important for neotropical migrant species, as well as for the characteristic breeding species of riparian habitats in the interior Columbia River Basin.

3.20.2 Research Natural Area

In addition to being an ecological reserve, the 120-square-mile ALE is an RNA, known as the Rattlesnake Hills RNA. An RNA is a physical or biological unit (or both) in which natural conditions are maintained insofar as possible by letting natural physical and biological processes prevail without human intervention (Federal Committee on Ecological Reserves 1977). Following are the objectives for establishing RNAs.

- Preserve examples of all significant natural ecosystems for comparison with those influenced by humans.[98]

- Provide educational and research areas for ecological and environmental studies.

- Preserve gene pools for typical and rare and endangered plants and animals.

In 1928, the USFS established the first RNA, the Santa Catalina Natural Area, on the Coronado National Forest in northern Arizona. Since then, the program has grown nationwide and includes designations by other federal agencies, as well as cooperation with state natural area programs and TNC. The RNA program in the Northwest began in 1931 when the Metolius RNA was established on the Deschutes National Forest in Oregon. RNAs in Oregon and Washington on federal lands are managed by the U.S. Department of Agriculture (USDA); the DOI (BLM, NPS and FWS); the DOD (Navy); and the DOE. Management differs somewhat between agencies, but the agencies all concur on the objectives for RNAs.

[98] In some circumstances, human intervention may be justified to maintain the feature for which the RNA was set aside. The introduction of prescribed fire in seral stands historically maintained by fire is an example.

Scientific use of RNAs has always been encouraged in Oregon and Washington. RNAs provide useful and essential information to land managers; they also contribute to basic science. Research activities must be essentially non-destructive, and the scientific and educational values of the areas must not be impaired. Each agency has a set of guidelines for use, but none is particularly restrictive as long as the essential characteristics and processes of the RNA are maintained.

The Rattlesnake Hills RNA was established as a result of a federal interagency cooperative agreement. The ALE constitutes the single largest tract in the federal RNA system for Oregon and Washington (Franklin et al. 1972), due in part to its being one of the few remaining large tracts of shrub-steppe vegetation in Washington that retains a predominant pre-European settlement character. The ALE is closed to general access by the public and is maintained for scientific purposes consistent with its value as an RNA.

3.20.3 National Register of Historic Districts

The National Register is the nation's official list of cultural resources worthy of preservation. Authorized under the NHPA, the National Register is part of a national program to coordinate and support public and private efforts to identify, evaluate and protect our historic and archeological resources. It is a list of buildings, sites, structures, objects and districts significant—at the local, state, or national level—in American history, architecture, archeology, engineering and culture. The NPS administers the National Register.

A National Register Historic District is a concentration of historic buildings, structures, sites, or objects united historically or aesthetically by plan or physical development. Any one of the properties in a historic district may not have particular historical, architectural, engineering, or archaeological distinction, but collectively they are significant in one of these areas.

The Secretary of the Interior established criteria to determine the eligibility of historic properties for inclusion in the National Register. All projects must be reviewed for any listed or eligible National Register sites in accordance with these regulations through the (Washington) SHPO. The following criteria are used to determine which sites qualify for listing.

- An association with events that have made significant contributions to broad patterns of our history.

- An association with significant persons in our past.

- Having distinctive characteristics of a type, period, or method of construction; having high artistic values; or being representative of a master or other significant entity.

- Having yielded, or being likely to yield, important historic or prehistoric information.

The Monument has a total of 127 sites evaluated for inclusion in the National Register, with forty-nine actually listed. Most of the National Register sites are part of six National Register Historic Districts (Hanford North Archaeological District, Locke Island Archaeological District, Rattlesnake Springs Historic District, Savage Island Archaeological District, Snively Canyon Archaeological District, Wooded Island Archaeological District), all of which are archaeological in nature and most of which comprise several sites. It is of note that the Hanford Site has a substantially higher percentage of archeological districts than historic districts; this characteristic is somewhat unusual nationwide.

3.20.4 Washington Heritage Register Sites

The Washington Heritage Register (WHR), maintained by the Washington Office of Archaeology and Historic Preservation, is similar in nature to the National Register of Historic Places. In fact, all National Register sites are automatically on the Washington Heritage Register. However, several resources on the Hanford Site are on the WHR but not the National Register. Sites eligible for the WHR must meet state-established criteria rather than national criteria. To be considered for inclusion in the WHR, sites, including buildings, structures and objects, must meet the following criteria.

- The resource must be at least fifty years old or have exceptional, documented significance.

- The resource must retain a high to medium level of integrity (i.e., defining characteristics from its historic period of construction).

- The resource must have documented historical significance at the local, state, or federal level.

In the Monument, there are three state archaeological districts—Coyote Rapids Archaeological District, Hanford South Archaeological District, and Wahluke Archaeological District. The Hanford Site also contains the Gable Mountain Archaeological Site.

Any sites listed in the WHR must be given consideration when evaluating projects requiring compliance with the State Environmental Policy Act. The SHPO reviews such documentation and makes recommendations on the effects of the project.

3.20.5 Traditional Cultural Properties Eligible Sites

A TCP is a recognized component of the National Register. Under the National Register, the word *culture* is understood to mean the traditions, beliefs, practices, lifeways, arts, crafts and social institutions of any community, be it an Indian tribe, a local ethnic group, or the people of the nation as a whole. One kind of cultural significance a property may possess, and that may make it eligible for inclusion in the National Register, is traditional cultural significance. *Traditional* in this context refers to those beliefs, customs, and practices of a living community of people that have been passed down through the generations, usually orally or through practice. The traditional cultural significance of a historic property, then, is significance derived from the role the property plays in a community's historically rooted beliefs, customs and practices. Examples of properties possessing such significance are:

- A location associated with the traditional beliefs of a Native American group about its origins, its cultural history, or the nature of the world.

- A rural community whose organization, buildings and structures, or patterns of land use, reflect the cultural traditions valued by its long-term residents.

- An urban neighborhood that is the traditional home of a particular cultural group and that reflects its beliefs and practices.

- A location where Native American religious practitioners have historically gone, and are known or thought to go today, to perform ceremonial activities in accordance with traditional cultural rules of practice.

- A location where a community has traditionally carried out economic, artistic, or other cultural practices important in maintaining its historic identity.

A TCP, then, can be defined generally as one that is eligible for inclusion in the National Register because of its association with cultural practices or beliefs of a living community that: 1) are rooted in that community's history; and 2) are important in maintaining the continuing cultural identity of the community. There are multiple sites in the Monument associated with ongoing Native American use, beliefs and ceremonial activities that likely qualify as TCPs; several potential TCPs and sacred areas are known to exist. Although no areas have been officially designated as TCPs, an area such as Rattlesnake Mountain (known to the native people as La Liik) is revered as a sacred area by all Native Americans in the area.[99] However, for reasons described below, the exact locations, boundaries and even numbers of potentially eligible TCPs in the Monument is unknown.

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[99] The DOE is currently working with local tribes in delineating and assessing the eligibility of Rattlesnake Mountain and associated areas as a TCP.

In the Monument, the significance of the environmental setting is integral to the Native American heritage connectivity or cultural traditions. Native people tie traditional, continuous use and occupation patterns to this land. Spiritual beliefs link plants, animals and sacred areas within the cultural landscape. Utilization of traditional hunting, gathering and collecting territory has been uninterrupted for generations.

The descendants of aboriginal people in the Columbia Basin practice cultural traditions and follow belief systems that may be recognized as being indigenous or traditional. Many of these cultural elements are expressed even today in collection and use of traditional resources such as foods, medicinal plants, and fibers. This cultural continuum expressed in the region within and surrounding the Monument is an important element of the ethnographic pattern of Native American expression within the cultural landscape. It represents an unusual and significant connection for Native American presence and land use patterns in the Columbia Plateau.

Traditional cultural values are often central to the way a community or group defines itself, and maintaining such values is often vital to maintaining the group's sense of identity and self-respect. Properties to which traditional cultural value is ascribed often take on this kind of vital significance, so that damage to or infringement upon such properties is perceived to be deeply offensive, and even destructive, to the group that values them. As a result, it is extremely important that traditional cultural properties be considered carefully in planning and that actions proposed under the CCP be respectful of Native American values.

TCPs are often hard to recognize. A traditional ceremonial location may look like merely a mountaintop, a lake, or a stretch of river; a culturally important neighborhood may look like any other aggregation of houses; and an area where culturally important economic or artistic activities have been carried out may look like any other building, field of grass, or piece of forest in the area. As a result, such places may not necessarily come to light through the conduct of archeological, historical, or architectural surveys. The existence and significance of such locations can often be ascertained only through interviews with knowledgeable users of the area, or through other forms of ethnographic research. The subtlety with which the significance of such locations may be expressed makes it easy to ignore them; on the other hand, this subtlety makes it difficult to distinguish between properties having real significance and those whose putative significance is spurious.

Identifying TCPs can present special challenges. First, those who ascribe significance to the property may be reluctant to allow its description to be committed to paper or to be filed with a public agency that might release information about it to inappropriate people.[100] Second, documentation necessarily involves addressing not only the physical characteristics of the

[100] Under Section 304(a)(3) of the NHPA, "The head of federal agency shall withhold from disclosure to the public, information about the location, character, or ownership of a historic resource if the Secretary and the agency determine that disclosure may . . . impede the use of a traditional religious site by practitioners."

property as perceived by an outside observer, but culturally significant aspects of the property that may be visible or knowable only to those in whose traditions it is significant. Third, boundaries are often difficult to define. Fourth, in part because of the difficulty involved in defining boundaries, it is important to address the setting of the property.

Particularly where a property has supernatural connotations in the minds of those who ascribe significance to it, or where it is used in ongoing cultural activities that are not readily shared with outsiders, it may be strongly desired that both the nature and the precise location of the property be kept secret. Such a desire on the part of those who value a property should of course be respected, but it presents considerable problems for the use of National Register data in planning. In simplest terms, one cannot protect a property if one does not know that it is there, which is one of the problems the FWS will face in implementing this CCP.[101]

3.20.6 B Reactor, Potential Historic Site

One of the unique components of the Monument is its association with the nuclear age and the Cold War. While other national wildlife refuges exist as the result of nuclear and other Cold War-era weapons (e.g., Rocky Flats, Rocky Mountain Arsenal), none are so closely linked with American history as the Monument. Over a three-decade span, nine reactors were eventually built on the Hanford Nuclear Reservation. Most famous among these reactors is B Reactor.

B Reactor was the first reactor built—there was no A Reactor at Hanford—and was the world's first industrial-scale nuclear reactor, producing weapons-grade plutonium. Completed in September 1944, B Reactor was a focal point of the top-secret Manhattan Project to develop the atomic bomb. Integral to World War II weapons development, B Reactor was part of the response to concerns over German development of nuclear capability (later learned to be unfounded). Completed in just thirteen months, it was one of three plutonium production reactors built in total secrecy at Hanford during WWII.

Apart from being the world's first major nuclear reactor, B Reactor holds many other distinctions. Plutonium from the B Reactor was used in the world's first nuclear explosion on July 16, 1945, at the Alamogordo Bombing and Gunnery Range in New Mexico. B Reactor

[101] The need to reveal information about something that one's cultural system demands be kept secret can present agonizing problems for traditional groups and individuals. It is one reason that information on traditional cultural properties is not readily shared with federal agencies and others during the planning and environmental review of construction and land use projects. However concerned one may be about the impacts of such a project on a traditional cultural property, it may be extremely difficult to express these concerns to an outsider if one's cultural system provides no acceptable mechanism for doing so. TCPs may be kept confidential under the authority of Section 304 of the NHPA.

plutonium was used in the Fat Man bomb dropped on Nagasaki, Japan, on August 9, 1945.[102] As a result of its history and the fact that it was the "first" in many categories, B Reactor has received many designations. B Reactor has the following current designations.

- National Historic Mechanical Engineering Landmark (American Society of Mechanical Engineers, 1976).
- National Register of Historic Places (National Park Service, 1992).
- Nuclear Historic Landmark (American Nuclear Society, 1993).
- National Civil Engineering Landmark (American Society of Civil Engineers, 1994).
- National Historic Landmark (National Park Service, pending).

Due to its role in history, there is a large amount of local and national support to preserve the B Reactor. This led to passage of Public Law 108-340 on October 18, 2004, which directed "the Secretary of the Interior to conduct a study on the preservation and interpretation of the historic sites of the Manhattan Project for potential inclusion in the National Park System." The NPS will assess the B Reactor—as well as the Cold War nuclear sites of the Los Alamos National Laboratory and town sites in New Mexico, Oak Ridge Nuclear Reservation in Tennessee, and a nuclear trigger production facility in Dayton, Ohio—for national significance and possible designation as a unit of the National Park System (e.g., national park, national historical park, national historical site). The NPS held public scoping meetings for B Reactor on March 22, 2006, with the scoping period concluding on June 30, 2006.

While not actually part of the Monument, the B Reactor lies just outside its boundaries, and interpretation of the B Reactor would be partially within the Monument. The most likely access route would begin in the Monument. If the B Reactor is preserved for public use and education, it will have significant impact on the Monument, and for that reason is being considered within this CCP as a reasonably foreseeable action.

3.20.7 Wilderness Eligible Areas

The Wilderness Act of 1964 directed the Secretary of the Interior, within ten years, to review every roadless area of 5,000 acres or more within NWRS and to recommend to the President the suitability of each qualifying area for inclusion in the National Wilderness Preservation System.

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[102] Fat Man, exploding in a twenty-kiloton blast, devastated more than two square miles of the city and caused approximately 45,000 immediate deaths and as many as 150,000 total deaths. Japan sued for peace five days later.

This assessment is still in progress. In August 2003, the FWS began the wilderness assessment for the Monument.

Using criteria derived from the Wilderness Act, FWS standards, and the BLM's Colorado and Utah State Offices, Monument staff and contractors developed a standardized checklist to be used in the wilderness assessment. This checklist was completed in the field using methodologies developed by the BLM for the Utah wilderness assessment.

With the completion of the field assessment, it was determined that three areas on the Rattlesnake Unit met the criteria as being potentially eligible as wilderness.[103] These areas included Bobcat and Snively Canyons and the southwestern-most corner of the Monument. However, at this time it has been determined that carrying these areas forward to the wilderness study phase is not compatible with the DOE's current mission for site cleanup and the protection of public property and safety. These areas will be re-examined when this CCP is revised and the mission of the DOE changes and cleanup for the Hanford Site progresses or is completed.

3.20.8 Wild and Scenic River Study Area

As the mission of the DOE at Hanford changed from production of plutonium to environmental restoration, the need for buffer lands diminished. Alternatives for disposition of these lands were proposed by different interests, one alternative of which was preservation of the area to protect the large block of shrub-steppe habitat and the unique assemblage of plant and animal species present. Equally as important a consideration as the shrub-steppe habitat was the last free-flowing segment of the non-tidal Columbia River remaining in the United States.[104]

In November 1988, Congress enacted Public Law 100-605, known as the Hanford Reach Comprehensive River Conservation Study Act, to address the future of the Hanford Reach and surrounding lands. The Act required the Secretary of the Interior, in consultation with the Secretary of Energy, to prepare a study that would evaluate the outstanding features of the Hanford Reach (including fish and wildlife, geologic, scenic, recreational, natural, historical, and cultural values) and its immediate environment (i.e., surrounding lands) and examine alternatives for preserving those values. The alternatives considered were to include, but not be limited to, inclusion of the Hanford Reach in the NWSRS. The study was to be conducted in cooperation with state, local, and tribal governments and with participation from the public and would conclude with a recommendation to Congress of a preferred alternative for preservation.

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[103] A copy of the wilderness assessment is available from the Monument.

[104] While the Hanford Reach is bounded upstream and down by hydroelectric dams, it retains some semblance to conditions supported by a natural flow regime and is free-flowing as defined by Section 16 of the Wild and Scenic Rivers Act (Public Law 90-542, as amended; 16 USC 1271-1287).

The Secretary of the Interior designated the NPS as the lead agency for the study. A study team was organized with representatives from the NPS, DOE and FWS. Their job was to conduct the study, prepare the necessary documentation, including the environmental analysis, and develop the agencies' recommendations for protection of the Hanford Reach.

In June of 1992, the NPS released the *Draft Hanford Reach of the Columbia River Conservation Study and Environmental Impact Statement*, followed by the final report and EIS in June of 1994. In that report, the NPS found that approximately fifty-one miles of the Hanford Reach—from one mile below Priest Rapids Dam (river mile 396.5) to the backwaters of the McNary Pool (river mile 345)—were eligible for designation into the NWSRS. The NPS study recommended that, should the Hanford Reach be designated, it be classified as recreational.[105]

Under the Wild and Scenic Rivers Act, eligible rivers must be free-flowing and support one or more "outstandingly remarkable resources" (ORVs)—"scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values" to be preserved in free-flowing condition so that "they and their immediate environments shall be protected for the benefit and enjoyment of present and future generations." ORVs are generally considered to be unique, an exemplary example of the type of feature, or of importance to the region or nation; this provides the basis for measurement of a resource as an ORV. While a designated or eligible river needs only one ORV to be eligible for designation, the NPS found that Hanford Reach supported the following seven ORVs.

- Fall-run Chinook salmon along with their spawning and rearing habitat.
- The intact ecosystem of the river and the adjacent Wahluke Slope.
- American Indian cultural resources.
- Archaeologic artifacts and sites.
- Hydrology and geology.
- Federally recognized rare animal species.
- Federally recognized rare plant species.

[105] Section 2(b) of the Wild and Scenic Rivers Act mandates that every designated river be classified as wild, scenic, or recreational. These classifications are based solely on the degree of development existing along the river at the time of designation, with wild being almost free of the evidence of man, and recreational rivers being "readily accessible by road or railroad, that may have some development along their shorelines, and that may have undergone some impoundment or diversion in the past."

The NPS study also addressed the "suitability" of the Hanford Reach for designation, concluding that it is suitable for designation.[106] The eligibility, classification and suitability findings were transmitted by Secretary of the Interior, Bruce Babbitt, to Congress along with the recommendation that the Hanford Reach be designated a national wild and scenic river under FWS management and that the Wahluke Slope be administered as a national wildlife refuge.

Following completion of the study and its subsequent transmittal to Congress, debate continued over the final disposition of the Hanford Reach and the surrounding lands. According to public opinion polls, the majority of Washington residents wanted the area protected according to the preferred alternative of the NPS study—designation of the Hanford Reach as a national wild and scenic river and protection of the Wahluke Slope as a national wildlife refuge. However, many interests in the immediate area were either opposed to further designations or wanted the area opened to other uses, agriculture being the primary use. This debate continued for several years, finally leading to creation of the Monument.

Creation of the Monument did not convey with it full protection of the river's eligibility as a wild and scenic river. In 1996, Section 404 of Public Law 104-333, the Omnibus Parks and Public Lands Management Act of 1996, amended the original study legislation (Public Law 100-605) to mandate that no federal agency may construct any dam, channel or navigation project. All other new federal and non-federal projects and activities shall, to the greatest extent practicable:

- Be planned, designed, located and constructed to minimize direct and adverse effects on the values for which the river is under study; and

- Utilize existing structures and facilities including, but not limited to, pipes, pipelines, transmission towers, water conduits, powerhouses and reservoirs to accomplish the purposes of the project or activity.

- Federal and non-federal entities planning new projects or activities in the study area shall consult and coordinate with the Secretary to minimize and provide mitigation for any direct and adverse effects on the values for which the river is under study.

Under the Wild and Scenic Rivers Act and DOI practices, the FWS will manage the river as if it were a wild and scenic river and will take no actions that would change its status. This

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[106] Eligibility is based on the physical characteristics of the river—free flow and river resources. Suitability refers to the social and economic feasibility and impacts of designation. There may be other, more suitable, ways to protect a river and its resources, or there may be more suitable uses for a river area than designation. Factors considered include the status of land ownership, including the amount of private lands involved; uses of the land that would be enhanced, foreclosed, or curtailed if the river were designated and the values lost if it were not; public and state/local government interest in designation; the costs of acquiring necessary lands and of administration of the river following designation; and other issues and concerns identified during the study process.

protection only partially extends to other federal agencies. Those agencies are obligated to take all reasonable care to protect the river's free flow and ORVs, but they are not obligated to forego projects if no reasonable alternative exists.

3.20.9 National Environmental Research Park

As early as 1952, ecological research on radionuclide cycling was underway at the Hanford Site and on land surrounding other nuclear weapons facilities. Scientists sought to understand the natural ecosystem and the transport, cycling and fate of radionuclides and other contaminants in soils, water and air. Out of the radionuclide research grew pioneering technologies for quantifying the movement of both natural materials, such as nutrients and fluids, and introduced pollutants through the ecosystem. In 1967, the Atomic Energy Commission formally designated a portion of the Hanford Site—the ALE—as a study area for scientists and educators. This environmental research designation was assigned two years before NEPA directed each federal agency and department to make environmental protection a part of its mission.

In an effort to comply with the spirit of Section 1 of NEPA, in 1977, the U.S. Energy Research and Development Agency (a predecessor to the DOE) developed the idea of National Environmental Research Parks (NERPs) and designated the entire Hanford Site as one of seven NERP sites in the United States. A NERP is an outdoor laboratory where research may be carried out to achieve national environmental goals, as articulated by NEPA, the Energy Reorganization Act, the Department of Energy Organization Act, and the Non-nuclear Energy Research and Development Act. The NEPA translated the public concern for a quality environment into environmental goals, and the NERPs network provided lands to help the nation and DOE comply with the spirit of NEPA. The Energy Reorganization Act of 1974 directed the DOE to engage in environmental research related to the development of energy sources so as to advance the goals of restoring, protecting and enhancing environmental quality. The NERPs are actually field laboratories set aside for ecological research, for study of the environmental impacts of energy developments, and for informing the public of the environmental and land use options open to them.

Because public access to DOE land is limited, environmental research projects can be carried out with a minimum of interference. Any land outside restricted areas may be made available by the DOE field manager for study under DOE's site-use procedures. The DOE has protected some areas of the ALE from all anthropogenic manipulations for more than sixty years in order that the area might serve as an environmental studies control area. While execution of the program missions of DOE sites must be ensured, ongoing environmental research projects and protected natural areas are given careful consideration in any DOE site-use decisions. Where appropriate, research parks may be established with other governmental agencies (through interagency agreements) such as the Rattlesnake Hills RNA.

3.20.10 Hanford Site Protective Safety Buffer Zones

Existing and planned waste disposal sites, waste processing facilities, and hazardous or radiological materials storage facilities are found throughout the Hanford Site. To protect the public from routine or accidental releases of radiological contaminants and/or hazardous materials, protective measures for waste remediation, processing and disposal facilities are required by numerous laws, regulations, rules and DOE internal orders.

One method of public protection, engineering control, uses the current Hanford Site boundary as the point-of-compliance to identify and design safety class systems, structures and components for operating facilities in both accidental and routine operation scenarios.

Another method of public protection, institutional control, uses distance as the protective measure expressed as safety buffer zones. These buffer zones limit public exposure to radiological and hazardous chemicals from routine operations and accidents. Some of these safety buffers extend into the Monument.[107]

The DOE divides the buffer zones necessary to protect human health and safety from potential accidents into two components—an inner exclusive-use zone (EUZ) and an emergency planning zone (EPZ). Within portions of the EUZ, certain types of access would be restricted, while other types of public access within that same area might be acceptable.[108] The protective buffer zones for the Hanford Site are established using boundaries calculated for individual limiting facilities (i.e., facilities, such as the water treatment plant, with accidents [e.g., a chlorine leak] of maximum potential public health impact). Information about the limiting facilities, controlling contaminants, and credible accidents for 1999, were presented in the CLUP.

In addition to known risks (e.g., Hanford's radioactive waste Tank Farms), the DOE reserves land for operational safety and/or remediation/stewardship buffer zones for unknown risks.[109]

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[107] At a minimum of every five years, the DOE revisits the buffer zones through various methodologies to determine the location, size, shape and characteristics of the buffer zones needed for the Hanford Site, using information from existing safety analysis reports, hazard assessments, and emergency planning zone studies. This process allows the restriction of potential land uses in areas where hazardous or radioactive material handling could pose an unacceptable risk to human health.

[108] The only current buffer zone in the Monument is that surrounding the K Basins. It is anticipated that this zone will be reduced such that it does not encroach on the Monument within a decade or less. However, The plutonium finishing plant may require an increase in buffer area based on future emissions.

[109] It is extremely difficult for the DOE to adequately characterize heterogeneous burial grounds created more than forty years ago (e.g., the 618-4 burial ground near Richland had approximately 1,500 barrels of uranium fines packed in mineral oil that was previously unknown). The EUZ and EPZ boundaries provide a conservative buffer zone based on risk and consequence management that is expected to be sufficient to address protective zone needs for the multiple facilities present in each area on the Hanford Site. As the cleanup mission progresses, the extent

In addition to DOE's protective buffer zone requirements, the security and emergency preparedness needs of Energy Northwest (formerly Washington Public Power Supply System) must be considered. Under U.S. Nuclear Regulatory Commission procedures, the Energy Northwest WNP-2 Reactor requires a 10-mile EPZ and a 1.2-mile EUZ, both of which cover Monument lands. Energy Northwest has placed public warning sirens in appropriate areas within the Monument consistent with NRC requirements; however, any new activities proposed under the CCP may require additional warning sirens.

3.21 Additional Management Considerations

While the Monument presents numerous management challenges, there are four—fire, elk, river flows, and sites of (potential contamination) concern—that are highly controversial and that are exceptionally challenging for a number of reasons. All are influenced by outside actions, and in the case of river flows, almost entirely outside the control of the FWS. All represent significant social problems/concerns, perceptions and attitudes that likely exceed the biological or cultural resource challenges. All involve significant costs to resolve or control, either to the agencies involved or to society. Finally, all are at least in part beyond the scope of this CCP. Fire management and control have already been addressed through a separate plan, which will need revision and will become a step-down plan to this CCP. Additional elk management methods may need to be addressed through a step-down plan, although the basis is addressed within this CCP. River flows are beyond the scope of this CCP—other than to note their known and potential impacts—and are being addressed through the FERC licensing process and other venues. Finally, the Hanford Site is one of the largest CERCLA sites in the United States. While most of the lands within the Monument are not contaminated, there are "sites of concern" that require additional investigation and management consideration.

3.21.1 Fire

In the desert, shrub-steppe environment that comprises the Monument, fire is one of the biggest threats to natural and cultural resources, as well as to human life. The Monument devotes considerable time, money, personnel and other resources to the management, suppression and strategic use of fire to protect and enhance natural, cultural and recreational resources, as well as to safeguard life and property.

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of these EUZs is expected to shrink in size and eventually migrate inward to the Central Plateau within Central Hanford (e.g., the K Basins).

One of the step-down plans associated with this CCP is a Fire Management Plan. The Fire Management Plan is unique among the Monument's step-down plans in that it has already been written, approved and implemented.[110] An environmental assessment for the Fire Management Plan was issued on April 3, 2001, and a finding of "No Significant Impact" was issued in June 2001. The plan is an operational guide for managing both the Monument's wildland and prescribed fire programs.[111] The plan defines levels of protection needed to promote firefighter and public safety, protect facilities and resources, and restore and perpetuate natural processes within the context of current understanding of the complex relationships in natural ecosystems. While the Fire Management Plan is already in place, there may be a need to rewrite or supplement it depending on the management alternative chosen for this CCP.

3.21.1.1 Fire Season

Records show that fire season is typically from May to mid-September. Depending on the specific weather of any particular year, the fire season may start earlier or last longer. Most fires in the area occur during the summer months, with the majority of ignitions in June, July, August and September. Although precipitation-free months are rare, summer months are generally hot and dry, averaging sixty-five days of 90º or more during the summer with only 0.3 inches of precipitation per month. Usually, July and August have some dry lightning storms that pose ignition hazards across the Columbia Basin.

3.21.1.2 Fire Ecology

Fire has played an integral role in the shrub-steppe environment. The bunchgrass component of the native shrub-steppe is a discontinuous fuel bed that prevents many large fires (Paige and Ritter 1999). Prior to manmade disturbances,[112] the historic fire regime was a thirty-two- to seventy-year fire return interval (Quigley and Arbelbide 1997) of small, high-intensity fires that removed small patches of the fire-intolerant shrub overstory. Small, infrequent fires maintained

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[110] The Fire Management Plan is available on request or can be downloaded from the Monument's web site at hanfordreach.fws.gov/fire.html.

[111] The Monument will suppress all wildland fires using appropriate management strategies. Prescribed fire will reduce hazardous fuels and/or improve wildlife habitat through the preparation of prescribed fire plans.

[112] It is highly possible that Native American's used fire to shape the landscape, drive wildlife, etc., as they did in other parts of the country. However, until additional factors, such as extensive livestock grazing, introduction of exotic species, and farming, significantly altered the ecology of the area, fire would likely not have had as significant an impact as it does today. Fires set by Native Americans could arguably be considered part of the historic, natural fire regime, if indeed fires were purposely set in the Columbia Basin.

bunchgrass openings within the shrub-steppe, providing for both shrub and grassland communities.

However, the historic fire regime has been significantly altered by sociopolitical and economic factors. After the 1900s, human activities interrupted the natural fire interval and patterns of burning. Agricultural development and livestock grazing reduced the light fuels that would normally carry a fire. Livestock grazing also had the effect of suppressing native bunchgrasses and allowing non-native invasive species (e.g., cheatgrass) and native sagebrush densities to increase.

Fire suppression organizations developed in the early twentieth century nationwide. Beginning about 1906 through the present, fire suppression efforts have resulted in increased sagebrush stand density. This allows for hotter, more destructive fires, due to the closer proximity of each individual plant, which allows fires to spread within the shrub canopy.

Of even greater impact, though, is the introduction of cheatgrass and other invasive species and noxious weeds. Rangeland "improvements" brought in a variety of non-native grasses, either as purposeful introductions to provide forage enhancement, or as accidental introductions in seed/pasture mixes. Plants such as cheatgrass, tumbleweed, and other annual species altered the native plant community structure. The discontinuous fuel that native bunchgrasses provided were invaded by thick, continuous fuels that would carry fires over large areas. Cheatgrass also cures into dry fuel earlier in the fire season than native grasses, providing a longer fire season. A high mortality of perennial grasses may occur if fire burns in a cured litter of annual grasses while perennials are still actively growing. Fires that start in cheatgrass stands often spread to surrounding habitats, resulting in the loss of shrubs from adjacent communities.

Finally, the arrival of settlers brought additional sources of wildfire. Even today, many fires on the Monument are ignited by such sources as cigarettes, sparks from machinery, and motor vehicles. The 24 Command Fire, one of the most destructive in recent history, was caused by a highway accident.

Particularly hard-hit by modern, high-intensity fires are sagebrush and other shrubs; sagebrush does not tolerate fire, while native grasses are more fire-tolerant. The natural recovery of sagebrush stands following a fire is further hampered by the presence of invasive species, which often outcompete sagebrush following a disturbance such as fire. Additionally, sagebrush totals only 15–25% of the vegetative cover in sagebrush shrub-steppe communities, and although wind can disperse sagebrush seeds up to ninety feet, most seeds fall within three feet of the canopy (Meyer 1994 *in* Paige and Ritter 1999), so the natural reintroduction of sagebrush into an area can take decades.

In summary, the contemporary fire regime is a short fire-return interval of large, high-intensity fires that remove large patches of the fire-intolerant shrub overstory. The invasion of cheatgrass has changed the community appearance and altered the fire regime because of an abundance of

available and continuous fuel. Natural succession has been altered by cheatgrass such that burned areas do not recover to their former community structure following fire. This has led to a decrease in the fire intolerant sagebrush and a commensurate increase in exotic species, primarily cheatgrass and tumbleweed, thereby creating a cycle that is hard to break.

Table 3.31. Wildfire History Since 1991.

Calendar Year	Wildfires	Acres Burned
1991	2	181.6
1992	5	4,032.1
1993	5	12,951.2
1994	3	1,042.4
1995	3	2.7
1996	1	5.0
1997	2	10.1
1998	7	8,265.0
1999	10	1,286.8
2000	5	78,900.1
2001		
2002		
2003		
2004		

3.21.1.3 Fuels

The fuel types in shrub-steppe are typically grass and shrub. The fuel is generally herbaceous plants that are dormant, or are nearly dormant. Occasionally, litter and dead/down stemwood from the open shrub overstory contributes to the fire intensity. Fires in this fuel type are surface fires that move rapidly through the cured grass and associated material. In rare instances, brush can become the primary carrier of fire spread; however, brush requires moderate winds (more than eight miles per hour at the mid-flame height) for fire to spread from crown to crown.

Four different fuel types are currently recognized on the Monument.

- ***Native grasslands*** are characterized by dry, open, grassy areas, with individual grass clumps providing a discontinuous natural fuel. Native perennial grasses and forbs are found throughout this community. Perennial grasses and forbs tend to have long, fibrous root structures that can access moisture throughout the soil profile. Thus, native vegetation in this area remains green during the first half of the fire season, curing out

during the late summer, typically July and August. Fires during late summer can burn within these areas. Perennial grasses may suffer high mortality if fires fueled by cured annual grasses burn perennial species during their active growing season, or if they burn at such a high intensity that the crown (the actively growing part of the plant) is damaged or killed. Fires during late summer can burn within perennial grassland areas. Occasionally, depending upon wind conditions, surface fires can move rapidly through the cured grass and associated materials.

- ***Shrub-steppe*** areas are grasslands that retain a component of shrub as an overstory. Wyoming big sagebrush is the most common, dominant shrub, but there are also communities of three-tip sagebrush, bitterbrush, black greasewood, spiny hopsage, and gray and green rabbitbrush. Generally, the shrubs burn with greater intensity than the grasses and produce longer flame lengths. Sagebrush has volatile, flammable chemicals associated with its foliage. In some areas, the shrubs can burn with such intensity that they permanently destroy the understory plants and create hydrophobic conditions on the soil surface.

- ***Riparian and riverine bottoms*** are occupied by willow-dominated communities. Because of their proximity to water, riparian and riverine habitats tend to have a high density of shrubs and trees and a greater amount of vertical structure. Native and non-native grasses are found in the understory throughout the community. Vegetation in this area remains green during the majority of the fire season, but as the grasses cure, the understory becomes more flammable. Dried grasses and shrubs can provide ladder fuels that burn into the riparian tree canopy and can kill overstory trees. Occasionally, aquatic vegetation can build up such that open water habitat becomes limited. These situations may require fire to reduce such buildups.

- ***Non-native plant communities*** are dominated by invasive species such as cheatgrass, tumbleweed and other exotic plants. Cheatgrass germinates in late fall, winter and early spring and cures earlier than native grasses, usually by early June. As the cheatgrass cures, it becomes an available and abundant fuel. Often, fires start within the cheatgrass and spread to other adjacent communities. Subsequently, other plants are exposed to burning earlier in the fire season than they historically would have been. This weakens native plants because they are burned during the peak of their growing cycle, which allows cheatgrass to spread further into native plant communities. This reduces biodiversity and accelerates the fire cycle.

3.21.2 Elk

The Monument is within the home range of an impressive elk herd, the Rattlesnake Hills Elk Herd. The Rattlesnake Hills Elk Herd is identified as a sub-population of the Yakima Elk Herd,

which also includes the Cascade Slope Elk Herd (WDFW 2002). The Rattlesnake Hills Elk Herd resides east of the Yakima River and west of the Columbia River in the Rattlesnake Hills region. Archaeological evidence suggests that elk inhabited these areas over the past 10,000 years; however, they have not been found here since at least the mid-1800s based on discussions and writings of Native Americans, early explorers, and settlers. Following their extirpation from Washington, the area was devoid of elk for several decades until the 1930s, when Rocky Mountain elk were brought from Yellowstone National Park in Wyoming and reintroduced to Washington in the Cascade Mountains near Mt. Rainier. Elk were first seen on the Monument (ALE) in 1972 (Fitzner and Gray 1991). This original group of animals was believed to originate from the Cascade Mountains to the west and arrived naturally. Since approximately 1975 (Rickard et al. 1977), the Rattlesnake Hills Elk Herd core range has been the ALE and private land to the south and west (Tiller et al. 2000). Peripheral rangelands include the Hanford Site, the Rattlesnake Hills west of State Route 241, the Yakima Training Center, and southern Grant and western Franklin Counties.

The Rattlesnake Hills Elk Herd has achieved a high reproductive rate, averaging an approximate 25% annual increase. This reproductive output, coupled with low annual harvest, led to substantial population growth throughout the 1980s and 1990s; by 1998, the population was estimated at more than 800 animals. The increasing herd size prompted multiple concerns, including damage to private agricultural lands, potential damage to fragile resources on the Monument, vehicle collisions and public safety on State Route 240, and increased elk presence within Hanford Site surface contamination areas. Efforts to reduce the herd have had some success. Since 1986, hunting seasons on private lands around the ALE have actively harvested elk. The WDFW has continued to liberalize hunting seasons on adjacent lands in order to reduce the herd and alleviate some of the above concerns. Further, the FWS, along with the WDFW and DOE, have conducted two capture and relocation efforts to reduce the herd. In 2000, 191 animals (primarily cows) were removed and taken to the Blue Mountains in Asotin County and the Selkirk Mountains in Pend Oreille County. In 2002, a smaller capture/relocation removed thirty-two animals to the Spokane Indian Reservation. Both increased hunting success and the capture/relocation efforts, combined with reduced calving rates in recent years, have contributed to the reduction in the elk population from its historic high.

The FWS and WDFW have been cooperatively monitoring the Rattlesnake Hills Elk Herd population on the ALE since 2001. Standardized winter inventories conducted over the last two years have estimated the herd to be approximately 670 (2005) to 538 (2006) animals. These surveys indicated that the herd maintains an approximate 38:62 sex ratio of bulls to cows. Calf recruitment typically adds about ninety animals/year, and annual harvest on lands adjacent to the ALE is between fifty-seventy animals; additional animals are likely removed by natural or other causes (e.g., killed by vehicles).[113] As the WDFW's current population level goal (post-

[113] Exact harvest levels are unknown at this writing and are based on hunter success reports and landowner permits issued.

harvest) for the Rattlesnake Hills Elk Herd is 350 animals (WDFW 2002), the herd is still above the targeted level for management.

Movements of the Rattlesnake Hills Elk Herd have been monitored through tracking radio-marked elk. The PNNL began annual monitoring of the herd from the late 1970s (shortly after the herd established itself in the Rattlesnake Hills) through the spring of 2001 (Rickard et al. 1977; Eberhardt et al. 1996; Tiller et al. 2000; Tiller unpublished data). The summer of 2001 was the last season of intensive monitoring by the PNNL. At that time, while the distribution of radio-collared elk had remained relatively stable between the 1980s and 2000, increased use of lands south of Rattlesnake Ridge and north of State Route 240 was observed in 1999, 2000 and 2001. Both population growth and the effects of wildfire in 2000 may have played a role in the shift of radio-marked elk movements. It is possible that elk use areas may change again in the future.

The Rattlesnake Hills Elk Herd is a wide-ranging natural herd. Elk have habituated to the use of agricultural lands as agricultural development has encroached on native habitats within their home range in the Columbia Basin. Much of their current range may be attributed to behavioral shifts based on resource availability on the landscape, and it is unknown if herd reduction alone will resolve the current management concerns.

3.21.3 River Flows

The Hanford Reach lies just downstream of the Priest Rapids Dam, which is part of a two-dam hydroelectric project—the Priest Rapids Hydroelectric Project—owned and operated by the Public Utilities District #2 of Grant County. The project consists of Priest Rapids and Wanapum Dams and is licensed by the FERC as Project #2114. These dams significantly impact flows through the Hanford Reach, although their overall ability to modify flows in the Columbia River is greatly influenced by the operation of larger water storage facilities upstream, such as Chief Joseph and Grand Coulee Dams. These dams, as well as several other federal and privately owned dams on the Columbia and Snake Rivers, have completely altered the flow regime and natural environments of the Columbia River System. For additional discussion of the water flows in the Hanford Reach, see Section 3.3.1.1.[114]

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[114] See all of Section 3.3, Hydrology, for the hydrologic benefits of dams to the region—flood control, water storage, etc. In addition to these beneficial impacts, dams on the Columbia River also provide for hydroelectric generation, reservoir recreation, barge transportation, and irrigation.

These projects have recently gone through the process of being issued a new license by the FERC. The EIS associated with that licensing provides a full description of the environmental and social impacts, both beneficial and non-beneficial, of these dams on the river, the region, and the nation. This CCP/EIS is only concerned with noting the impacts of the dams on the Monument. However, these dams have impacts reaching far beyond the borders of the Monument, and it is the responsibility of the FERC to address those impacts in the licensing EIS.

Although development of the Columbia River hydrosystem has not eliminated the relatively free-flowing Hanford Reach and its unconstrained alluvial floodplain, it has altered the timing and magnitude of the hydrograph, both seasonally and hourly. The spring freshet has been reduced by storage of higher flood and channel maintenance flows in reservoirs for flood control and for power generation during summer and fall. Hourly regulation of the hydrosystem, which is conducted to meet electrical demand in the region (load following), results in water level fluctuations of six–ten vertical feet in a matter of hours. Flow levels and fluctuations affect the interaction between surface water, groundwater and the associated convergence zones.

These seasonal and daily flow alterations from the natural condition affect the Hanford Reach, although the exact extent of impact is under debate. The rapid and continuous water level fluctuations that occur in the Hanford Reach may have the most significant impact on aquatic species, including benthic macroinvertebrates, anadromous fish, and resident fish (see Section 3.10.1.5.1 for a discussion of the impacts of river fluctuations on juvenile salmonids). Alternate drying and rewetting of wetlands, riparian zones, and shallow-water habitats limit the production of aquatic plants and invertebrates that are important as forage species for both wildlife and juvenile fish. The stability and productivity of the riparian zone, islands, wetlands, sloughs, backwaters and other shallow-water habitats is a function of streamflow levels and fluctuations; the artificial hydrograph and, to a greater extent, the short-term hourly fluctuations currently compromise the productivity of these habitats, although the degree of impact is unknown. Fluctuations may also be affecting populations of persistent-sepal yellowcress, a rare plant species found in the wetted zone at water's edge (see Section 3.9.7.15). Fluctuations in water levels can also flood bird nests along the island shorelines and well into nesting trees.

Flow fluctuations may also be affecting erosion rates within the Hanford Reach. The daily inundation and dewatering of the inherently unstable soils within the Hanford Reach may exacerbate natural erosion, although this is unproven and additional study is necessary. However, if natural erosion rates are accelerated, there could be several far-reaching implications. Cultural resources would be eroded out of the strata, thereby either losing the resource itself or losing its archeological context. Aesthetics would be negatively affected. Siltation of salmon redds might occur. Water quality would be affected. Finally, the loss of the White Bluffs could be furthered beyond that taking place through landslides (see Section 3.7.4). While none of these impacts are proven to be occurring and are not shown to be directly tied to flow fluctuations, further study is warranted.

River fluctuations also affect recreational use of the Hanford Reach. Flow fluctuations have resulted in vehicles parked at boat launches becoming submerged as well as beached boats being swept away. Flow fluctuations either slow or speed human-powered boat trips. High flows may

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Please refer to that document for a full discussion of the impacts of the Priest Rapids Dam Complex, including things like the need for electrical power, the benefits to irrigation, the environmental trade-offs associated with replacement power, etc.

create turbulent conditions, thereby creating a potential swamping situation. Low flows may lengthen trip times to such an extent that some boaters are unable to complete their trip during daylight hours. Daily low flows also create navigational concerns for motor boaters. Daily fluctuations impact aesthetics by occasionally creating a flooded landscape or by creating a "bathtub ring" along the shoreline (i.e., an area where no vegetation grows due to the daily fluctuations). These dewatered areas are also of safety concern from the exposure of algal- and silt-encrusted rocks, which are extremely slippery.

3.21.4 Sites of Concern

As previously noted, most of the land within the Monument boundary is held by the DOE. However, the eventual planned disposition of the majority of this land area will be to transfer it to the FWS.[115] Prior to the transfer of title, the FWS must be assured, either by outside agencies (e.g., EPA or WDOE) or by internal assessment, that the lands meet FWS standards regarding possible residual contamination and/or physical hazards. While most of the lands within the Monument are considered clean and can be transferred quickly, there are some areas that will remain with the DOE for the long term (e.g., lands around reactors) or that require additional assessment prior to transfer.

At present, there are approximately fifty of these sites of concern—areas that require additional assessment (see Map 22). Potential contaminant concerns at these sites range from oil spills to prior applications of insecticides such as DDT. In addition, there are concerns over potential physical hazards, ranging from uncapped wells to minor excavations. In some instances, it is likely that limited remediation could return the property to a condition that would be acceptable for transfer to the FWS. For contaminants, all that might be required is excavation of contaminated soils in specific areas and their proper disposal elsewhere. For physical hazards, backfilling holes or providing an appropriate permanent cover might be adequate. Although these sites have been identified as requiring further investigation, an assessment at any particular site could reveal that there are no problems and no further action would be required. Furthermore, many of the concerns are related to resident wildlife with life-long exposure to the site; transitory contact by wildlife or human visitors may not be a health concern.

[115] The transfer of lands is a separate process from the development of this CCP. All NEPA analysis related to land transfer will be carried out through that process, as well as the complete description of the land area and any associated concerns about contamination and physical hazards.

3.21.5 Islands

There are nineteen islands located in the Columbia River upstream of Richland, Washington, that are managed by the FWS and included within the scope of this plan. Six islands are currently managed by the McNary National Wildlife Refuge (McNary Islands); the three islands furthest upstream are actually within the Monument's boundaries). The remaining thirteen are managed by the Monument (Hanford Islands). The McNary Islands are located from river mile 341, just north of the Snyder Street Boat Launch in Richland, upstream to the first powering crossing at river mile 351. Upstream of river mile 351 are the thirteen Hanford Islands, which are held in fee title by a mixture of the ACOE, BLM, DOE, FWS and WDNR. One island (Homestead) is a mixture of federal and private ownership; this CCP applies only to that portion owned by the federal government.

Although all nineteen islands are natural features within the Columbia River, and not man-made through dredging or development, some vegetation on these islands is different than what would be historically present in a natural river setting. Tree species were not historically prevalent; natural flood flows annually scoured these islands, thereby reducing the potential for tree establishment or survival. Likewise, naturally occurring native species are not as abundant on shorelines due to daily fluctuations of river levels as discussed above. Nonetheless, these islands today hold a wealth of sensitive biologic and irreplaceable cultural resources unique to the entire Columbia River system.

3.21.5.1 Island History

The islands of the Hanford Reach have been used for thousands of years as important dwelling, gathering and food processing places for Native American peoples. In the late 1800s to early 1900s, the islands were also used by homesteaders and river operators. In 1943, all public access to the islands and approximately forty-eight miles of the Columbia River upstream of Richland was closed due to site security and public safety needs associated with construction of the nuclear reactors. In the early 1970s, the Hanford Reach was reopened to public access along its entire length. Although the islands remained closed to the public above the ordinary high water mark, the shoreline areas below this level have been used by hunters and fishermen for more than forty years.

The McNary Islands were withdrawn from the public domain by the Department of the Army for flood control purposes through Public Land Order 606, dated September 13, 1949. The McNary National Wildlife Refuge was established on April 30, 1956. A cooperative agreement between the ACOE and FWS, established in September 1963 and amended in September 1969, provided for the protection and management of islands and shorelines of the Columbia River, including the McNary Islands. Under the cooperative agreement, the FWS would provide "maintenance and management of wetlands resources of and habitats thereon, particularly non-

migrating birds, fish, waterfowl, and upland birds." The McNary Islands would also be managed to provide for waterfowl nesting, resting and feeding habitats.

Seasonal public use (July 1 - September 30) occurred on the McNary Islands for several years following the reopening of the river. However, following a lawsuit settlement in 1993, the McNary Islands were again closed to summertime public use in 1994 for the protection of shorebird and migratory waterfowl breeding, nesting and rearing habitat.[116] The five upstream islands remained open to waterfowl hunting. (The downstream island is within the city limits of Richland and hence closed to firearm use.)

While the islands' closure was implemented in 1994, the islands' shorelines have continued to receive public use due to fluctuating Columbia River water levels, which regularly expose the shorelines below the ordinary high water mark.[117] Typical recreational uses of these areas include hunting, fishing, picnicking, camping, waterskiing, sunbathing, swimming and social gatherings. However, these activities are frequently extended beyond the high water mark and into the closed portion of the islands, in particular on Island 19 due to its proximity to a public boat launch and its long, sandy beach. Unfortunately, because the islands are so small, it is easy to significantly affect resources through public use. Impacts on wildlife resources from shoreline activities—especially those that extend above the mean high-water mark—include disturbance of colonial nesters (especially during pre-nesting when birds can be disturbed from nesting, as well as later when there are young flightless birds); destruction of bank swallow nesting sites; disturbance to breeding waterfowl; and interruption of foraging and resting activities by a wide range of raptors, passerines, wading birds, waterfowl and mammals. Other impacts include unsanitary waste, littering, fire, noxious weed spread, and unauthorized collecting. Renewed patrols and signing efforts to enforce the court-ordered closure of the McNary Islands were undertaken in 2004, with varying degrees of public acceptance.

3.21.5.2 Island Wildlife Values

Islands provide important nesting and foraging habitat and escape cover for many species of birds and mammals, including waterfowl, migratory water and shore birds, colonial water birds, neotropical birds, and deer. Nesting on the islands has increased through the years, especially by ring-billed and California gulls. Great blue heron and great egret rookeries have increased on Island 17. Other bird species using the islands include black-crowned night-heron, Forster's tern, Caspian tern, killdeer, pelican, Canada goose, mallard, teal and bank swallow. Foraging

[116] The lawsuit, filed by the National Audubon Society and other conservation interests, challenged the FWS compatibility determinations for allowed uses of the islands.

[117] The riverbed and shorelines up to the ordinary high water mark are controlled by the WDNR and are open to public recreational uses.

species frequenting the islands include white pelican, long-billed curlew, spotted sandpiper, black-necked stilt, and American avocet. Wildlife, such as deer, likely seek out the islands for breeding habitat for safety and security and in order to avoid some mammalian predators. Other wildlife, such as river otter and mink, use the islands extensively.

Shoreline riparian communities are seasonally important for a variety of species. Willows trap food for waterfowl (e.g., Canada geese) and birds that use shoreline habitat (e.g., Forster's terns), as well as provide nesting habitat for passerines (e.g., horned larks). Terrestrial and aquatic insects are abundant in emergent grasses and provide food for fish, waterfowl and shorebirds.

3.21.5.3 Island Vegetation

Plant communities on the islands consist of very complex terrestrial and aquatic systems, including riffles, gravel bars, oxbow ponds, backwater sloughs, and cobble shorelines that are otherwise rare in the Columbia River today. In order to provide a concise analysis of current conditions on the islands, riparian vegetation classifications have been simplified.[118] Island plant communities have been classified into the following five primary groupings.

3.21.5.3.1 Wooded

These are islands with plant communities comprising tree and shrub overstories and forb and grass understories. Shorelines are ringed by shrub species including willow, poplar and mulberry. Tree species are prevalent on shorelines and the interior portions of the island and serve as nesting and roosting habitat for many species, including egrets, herons, hawks, owls and eagles. Understory species along shorelines include smartweed, sedges, rushes, horsetail, reed canary grass, and barnyard grass. The uplands are primarily cobble or sand dunes and contain a higher percentage of cover than other islands. Upland vegetation includes bulbous bluegrass, sand dock, buckwheat, balsamroot and non-native species including cheatgrass and kochia.

3.21.5.3.2 Sparsely Wooded/Shrub

These islands characteristically have shorelines occupied by small groves of shrubs, including willow, poplar and mulberry. Siberian elm, cottonwood and sycamore are present but scattered across the uplands and shoreline. Shrubs and tree species provide hiding, roosting and nesting

[118] An extensive survey of riparian plant communities was conducted in 1995 (Salstrom and Easterly, TNC) and has been recently updated by the DOE and PNNL. Current information is synthesized in the 2005 Hanford Site National Environmental Policy Act Characterization.

habitat for a variety of wildlife species. Mature trees, generally mulberry, are used by herons and egrets for rookeries. The uplands consist of sand dunes and cobble. Upland plant communities contain bulbous bluegrass, sand dock, buckwheat, balsamroot, and non-native species, including cheatgrass, Russian thistle, and kochia. Stabilized sand dune soils provide habitat for bank swallow colonies but also provide small stretches of sandy beach that invite public use.

3.21.5.3.3 Grass/Cobble

These islands consist primary of cobble and sandy soils that support grass and forb species, with significantly less vegetative cover than the wooded islands. Shoreline areas consist of reed canary grass, smartweed, sedges, rushes, horsetail and barnyard grass. Scattered shrubs may be present along the shorelines but do not contribute to the overall vegetative makeup of the island. The uplands are primarily cobble or sandy soils and include a variety of native and non-native species, such as sand dropseed, Indian ricegrass, sagewort, sand dock balsamroot, buckwheat, lupine, lomatiums, curlycup gumweed, cheatgrass, willow-herb, Russian thistle, and mullein.

3.21.5.3.4 Grass/Cobble/Scattered Trees

These islands are similar in soils and vegetative characteristics to the grass/cobble islands, but they have scattered trees, generally mulberry, which are used by wildlife for nesting and roosting activities.

3.21.5.3.5 Cobble/Dune

These islands are composed of mostly bare cobble or silt soils. Shorelines and large portions of the island can be inundated almost daily during the growing season due to water flow manipulation upriver at Priest Rapids Dam (Salstrom and Gehring 1994). Plant species on these islands are similar to the grass/cobble classification, but the vegetation cover is generally less than 5%.

3.21.5.4 Specific Island Descriptions

Below are brief descriptions of ownership, island morphology, and unique wildlife habitat features of islands within the Hanford Reach. Slackwater areas around Islands 1 through 10 serve as important resting and spawning habitat for Chinook salmon and support a myriad of wildlife species that come to forage during the spring and fall anadromous fish runs. Coyotes, bald eagles, golden eagles, pelicans, cormorants, egrets, and herons are but a few of the wildlife

species that utilize these islands throughout the year. These descriptions detail unique features for each island; Table 3.32 summarizes island attributes. See Map #13 for island locations.

3.21.4.5.1 Island #1 (WDNR)

Located just south of the Wahluke town sites, the island is sparse/grass and cobble. The island is used by many wildlife species, including deer, geese, ducks, American white pelicans, and double-crested cormorants. The western portion of the island has pronounced cobble shores that are shallow and provide resting and foraging opportunities for many avian species.

3.21.4.5.2 Island #2 (BLM)

Island 2 is sparse grass and cobble and used by deer, geese, ducks and pelicans. A unique feature is a lone mulberry tree on the eastern shore that has been used as a great blue heron rookery for the past two years.

3.21.5.4.3 Island #3 (BLM)

The island is cobble/dune and used by many species including deer, geese, ducks, pelicans and coyotes. The sand dune features of the island have supported an active coyote den.

3.21.5.4.4 Island #4 (WDNR)

Island 4 is cobble with sparse vegetation cover. Shorelines serve as resting and foraging areas for many avian species.

3.21.5.4.5 Island #5 (WDNR)

Island 5 is cobble with sparse vegetation cover. Shorelines serve as resting and foraging areas for many avian species.

3.21.5.4.6 Island #6—Locke Island (DOE)

Locke Island has a grass/shrub cover type, provides hiding, nesting and foraging habitat for deer, geese, eagles and coyotes. In 2004, WDFW biologists described how coyotes pull salmon carcasses from the shoreline into grass or shrub cover on the upper bench of the island before

consuming the fish. The lee and slack-water sides of the island provide foraging habitat for bald eagles, which feed on the "zombies" (i.e., fish that have spawned and are near death in shallow pools near the island shores).[119]

Locke Island is situated at the north end of the White Bluffs Formation on the Hanford Reach of the Columbia River. Renewed landslide activity began in the White Bluffs about 1977, with several small landslides along a two-mile section of the bluff. By 1984, the landslides were a nearly continuous landslide mass. Landslide activity seemed to peak by the mid 1980s, but minor activity is still occurring. As the landslides amassed, the sloughed material was forced into the river toward Locke Island. The landslide mass has partially blocked the river channel on the bluff side and forced the river's path toward Locke Island.

During 1996–97, the river experienced record high runoff which, combined with the partial channel blockage, resulted in major erosion of Locke Island's east bank. The accelerated erosion has affected about 1,500 feet of Locke Island's east bank, with an average width of ninety feet lost. Studies of erosional process on the island resulting from the sloughing have been conducted since 2000.

Slough-related erosion has negatively affected vegetation, wildlife habitat, rare plant species, and cultural resources.

Noxious weeds on the island pose a threat to the biological integrity and stability of Locke Island.

3.21.5.4.7 Island #7 (WDNR)

Island 7 is sparse grass and cobble and used by many wildlife species including deer, geese, ducks, white pelicans, and double-crested cormorants.

3.21.5.4.8 Island #8 (DOE)

The island is sparse grass and cobble and is similar to Island #7. A survey conducted by the WNHP has identified this island as a potential reintroduction site for northern wormwood (*Artemisia campestris* subspecies *borealis* variety *wormskioldii*). Northern wormwood is a Washington State endangered plant species and an FWS candidate for ESA listing.

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[119] Bald eagles prefer to feed on the live fish rather than those that are dead on the shoreline, although they will also scavenge carcasses.

3.21.5.4.9 Island #9 (BLM)

This island is sparse grass and cobble and is similar to Island #8. This island is also considered a potential reintroduction site for northern wormwood.

3.21.5.4.10 Island #10 (WDNR)

Island 10 is sparse grass and cobble and is used by many avian species, including white pelicans, geese, cormorants and bald eagles.

3.21.5.4.11 Island #11 (BLM)

This island is sparse grass/shrub vegetation with scattered trees along the shoreline and used by a variety of wildlife. Noxious weeds on the island poses a threat to biological integrity and stability, as well as to rare plant species. Columbia yellowcress (*Rorippa columbiae*)—considered endangered by the state of Washington and a species of concern by the FWS—has been mapped on this island in the past; however, recent monitoring suggests that the population of plants has been significantly reduced in this area.

3.21.5.4.12 Island #12 (BLM)

This island is similar to Island #11, is sparsely vegetated by grass and shrub species, and is used by herons as a foraging area. Noxious weeds on the island pose a threat to biological integrity and stability, as well as to rare plant species. Columbia yellowcress has been mapped on this island in the past; however, recent monitoring indicates that the population of yellowcress in this particular area has declined significantly.

3.21.5.4.13 Island #13—Homestead Island (BLM, WDNR, Private)

This island has mixed ownership and has been affected by past development attempts. Past attempts to convert private lands to orchards altered vegetation on the island; however, following court-ordered restoration work, the island is primarily wooded with cobble uplands and shore on the north end of the island. Homestead Island provides habitat for avian species, as well as deer, coyotes, porcupines and other mammals. In March of 2006, up to 500 sandhill cranes were recorded as using the island as a roosting area. Noxious weeds on the island pose a threat to the biological integrity and stability, as well as to rare plant species. Columbia yellowcress has been mapped on this island in the past; however, recent monitoring indicates that the population of yellowcress in this particular area has declined significantly.

Table 3.32. Hanford Reach Islands.

Number/ Name	Ownership	Vegetation Cover	Biological Resources, Wildlife Species of Concern; Threats
1	WDNR	Sparse Grass/Cobble	
2	BLM	Sparse Grass/Cobble	Heron Rookery - Mulberry Tree
3	BLM	Cobble/Dune	Coyote Den
4	WDNR	Cobble	
5	WDNR	Cobble	
6 Locke	DOE	Grass/Shrub	Bank Swallow Colony; Noxious Weed Concerns*
7	WDNR	Sparse Grass/Cobble	
8	DOE	Sparse Grass/Cobble	Potential Northern Wormwood Reintroduction Site
9	BLM	Sparse Grass/ Cobble	Potential Northern Wormwood Reintroduction Site
10	WDNR	Sparse Grass/Cobble	
11	BLM	Shrub/Sparse Grass/Scattered Trees	Rorippa; Noxious Weed Concerns
12	BLM	Sparse Grass/Shrub	Heron Foraging Site; Rorripa; Noxious Weed Concerns
13 Homestead	Private/BLM/ WDNR	Wooded (Cobble North Side)	Rorripa; Noxious Weed Concerns
14 Wooded	FWS	Grass/Cobble	Noxious Weed Concerns
15	FWS	Grass/Cobble (Small Satellite Island)	Noxious Weed Concerns
16 Underwater	FWS	Wooded	
17 Johnson	FWS	Grass/Scattered Trees	Potential Northern Wormwood Reintroduction Site; Noxious Weed Concerns
18	FWS	Shrubs/Sparsely Wooded	Multi-species (Gull, Forster's Tern, Great Egret) Nesting/Rookery; Potential Wormwood Reintroduction Site; Noxious Weed Concerns
19	FWS	Shrubs/ Sparsely Wooded/ Dune/Cobble	Bank Swallow Colony; Potential Wormwood Reintroduction Site; Noxious Weed Concerns
20	ACOE	Wooded/ Cobble	Black-crowned Night Heron Rookery; Gull Nesting Colony
21 Nelson	City of Richland	Wooded	
*Noxious Weed Concerns: These islands possess noxious weed populations that would be affected through increased public use activities. The threat of weed movement to other locations through public use is high.			

3.21.5.4.14 Island #14—Wooded Island (FWS)

Wooded Island is grass/cobble and supports a variety of wildlife, including ducks, geese, pelicans, egrets and great blue herons. This island has been used by local waterfowl hunters. Noxious weeds on the island pose a threat to its biological integrity and stability and have the potential to spread to other lands as a result of public use of these lands.

3.21.5.4.15 Island #15 (FWS)

This island is grass/cobble and supports a variety of wildlife, including ducks, geese, pelicans, egrets and great blue herons. A small cobble "satellite" island is used by American white pelicans, great blue herons, and great egrets for foraging. The island has been used by local waterfowl hunters. Noxious weeds on the island pose a threat to its biological integrity and stability and have the potential to spread to other lands as a result of public use of these lands.

3.21.5.4.16 Island #16 (FWS)

This island is often referred to in historic management plans as Underwater Island. Daily river fluctuations inundate the lowlands and leave very little of the island visible and usable for wildlife. The island contains shrubs and immature trees on the upland portions and is classified as wooded here. The island is less than one acre in size with less than 25% of the island visible during high flows.

3.21.5.4.17 Island #17—Johnson Island (FWS)

The island is grass/scattered trees. Backwater areas of the island have been used by local waterfowl hunters. Noxious weeds, such as purple loosestrife, on the island pose a threat to its biological integrity and stability and have the potential to spread to other lands as a result of public use of these lands. A survey conducted by the WNHP has identified this island as a potential reintroduction site for northern wormwood.

3.21.5.4.18 Island #18 (FWS)

This island is sparsely wooded with shrubs on the shorelines. The island is extensively used by California and ring-billed gulls for nesting. Great blue herons, great egrets, and black-crowned night-herons have an established rookery in trees on the east side of the island. This rookery was severely damaged by a windstorm in March 2005, and few trees remain that will provide long-term nesting sites for these birds. The island also supports other avian species, including geese

and ducks. A survey conducted by the WNHP has identified this island as a potential reintroduction site for northern wormwood. Noxious weeds on the island pose a threat to its biological integrity and stability and have the potential to spread to other lands as a result of public use of these lands.

3.21.5.4.19 Island #19 (FWS)

Often referred to as Third Island by the general public, this island is sparsely wooded with groves of shrubs on the shoreline. Uplands are comprised of cobble and sand dunes and support a variety of wildlife, including bank swallows, geese, ducks, deer, coyotes and porcupines. Shallow cobble shorelines on the northern point of the island are used extensively by pelicans, herons, egrets, and cormorants for foraging. The sand dune structure of this island creates attractive sandy beaches that draw boaters and water skiers; however, the island is closed to all public access year-round. A survey conducted by the WNHP has identified this island as a potential reintroduction site for northern wormwood. Noxious weeds on the island pose a threat to its biological integrity and stability.

3.21.5.4.20 Island #20 (ACOE)

Island 20 is wooded with cobble uplands. Directly adjacent to the Snyder Boat Launch in Richland, the island is home to an active heron rookery that supports great blue herons and black-crowned night-herons. Geese, ducks, pelicans and gulls now use the island for foraging and nesting. This island, although outside the management purview of the FWS, directly contributes to the wildlife diversity of the Hanford Reach.

3.21.5.4.21 Island #21—Nelson Island

This island is owned by the city of Richland and is the last of the islands identified in the Hanford Reach of the Columbia River. Nelson Island is wooded and supports foraging and nesting habitat similar to that of Island #20. No active rookery has been established on this island due, potentially, to its location adjacent to a high-use city park. This island, although outside the management purview of the FWS, directly contributes to the wildlife diversity of the Hanford Reach.

3.21.5.5 Island Cultural Resources

The islands were historically used by Native American tribes and contain regionally and nationally significant cultural resources. Recorded archaeological sites tend to demonstrate

extensive use by Native American tribes over at least the past 10,000-12,000 years. The majority of site inventories represent a wide range of Native American site types, including pit house villages, campsites, fishing stations, root gathering and resource processing camps, caches, hunting blinds, rock cairns, hearth features, sacred locations, cemeteries, quarries and lithic tool production sites. Resource procurement and processing sites make up the bulk of sites on the islands, with nineteen of the twenty-three recorded pit houses on the Monument in the vicinity of the processing stations. One of these sites contains an extensive array of pit house depressions, one of the largest such villages remaining in the region.

Unfortunately, a cultural resource inventory of all lands within the Monument, including the islands, has not been completed to date. The DOE reports that 1,171 cultural resource sites and isolated finds have been documented on the Hanford Site (DOE 2003). Of these, 575 sites fall within the Monument, with just over half (367) in the Columbia River Unit; it is likely that many of these documented resources are located on the islands. However, because site records reflect various levels and styles of reporting, the database can be difficult with which to work.

3.21.5.6 Island Salmon Habitat

The islands also serve as an important habitat for salmon—a culturally significant resource for area tribes—for spawning and rearing of juvenile fish. A three-year study conducted by the FWS, USGS, WDFW, Yakama Nation, Columbia River Intertribal Fish Commission (CRITFC), and Alaska Department of Fish and Game shows that fall-run Chinook salmon spawning is concentrated in a number of specific areas scattered throughout the Hanford Reach (Anglin et al. 2005). The majority of known spawning in the Hanford Reach occurs in areas in the upper segment, primarily Vernita Bar (35%); the middle segment from White Bluffs to 100F slough (60%); and the lower segment near Ringold, Homestead Island, and Wooded Island (5%). Spawning habitat in the middle and lower segments of the Hanford Reach has been associated with water depths of six-twelve, water velocities of 4.6–6.6 feet/second, and areas with lateral slopes of less than 4% (Geist et al. 2000). In addition to the observations of shallow-water spawning, spawning beds have also been documented in deep waters (up to thirty feet), but the extent of deep-water spawning has not been quantified (Chapman et al. 1986; Swan 1989).

Impacts on salmon in the Hanford Reach include entrapment of juveniles and dewatering of redds due to river fluctuations, impacts associated with predation by native and non-native species, siltation and disturbance by human activities. Fall-run Chinook typically build their redds in clusters, making large-scale impacts more likely. Impacts on spawning fish, redds and juveniles can be reduced through cooperative management actions.